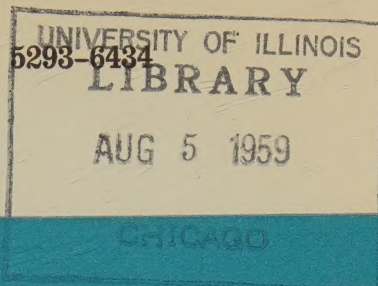


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SCIENCE ABSTRACTS: SECTION A



VOLUME 62

NUMBER 738

JUNE 1959

PHYSICS ABSTRACTS

Published by The Institution of Electrical Engineers

SECTION A OF SCIENCE ABSTRACTS

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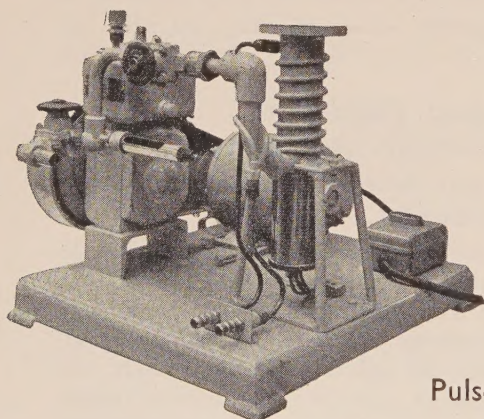
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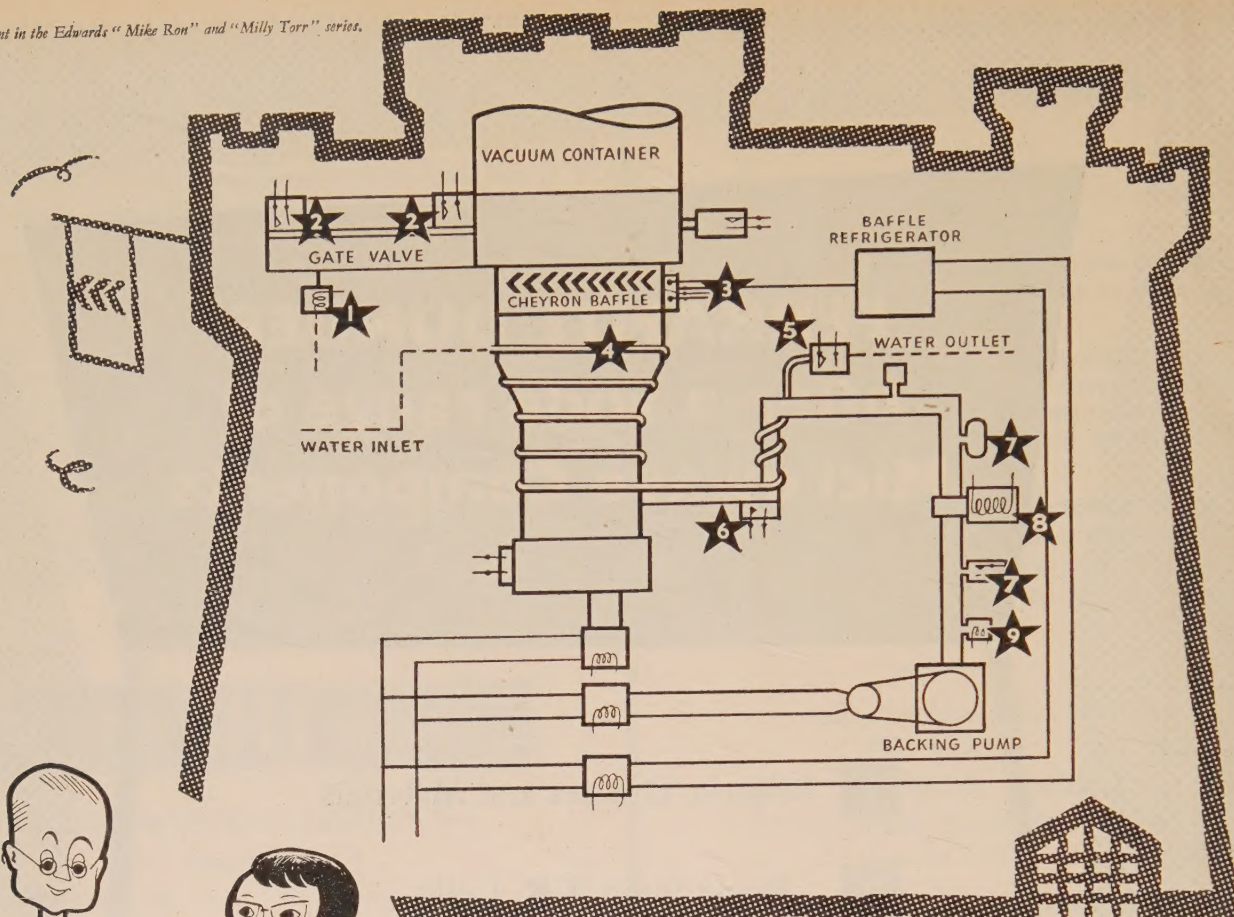
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PHYSICS ABSTRACTS

Volume 62

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MATHEMATICS

5293. A TABLE OF INTEGRALS

$$\int_0^{\infty} e^{-\alpha x} \frac{(1 - e^{-x})^p}{x^q + 1} dx.$$

K.V.Laurikainen and O.Varho.
Ann. Univ. Turku AI, Vol. 30, 68 pp. (1958).

513.43 : 535.241

DETERMINATION OF THE SOLID ANGLE FORMED BY A
CIRCULAR TARGET RELATIVE TO A POINT SOURCE. See
Abstr. 3245

517.564.4 : 550.38

SPHERICAL HARMONIC DEVELOPMENT OF THE GEO-
MAGNETIC FIELD TRANSFORMED INTO RECTANGULAR GEO-
MAGNETIC COORDINATE SYSTEMS. See Abstr. 5266

517.9 : 537.312.5

5294. THE METHOD OF CONTROLLED ACTIVATION
[GESTEUERTEN ANREGUNG] (AN EXPERIMENTAL METHOD FOR
THE ACCURATE ESTIMATION OF PARAMETERS FROM GIVEN

SYSTEMS OF DIFFERENTIAL EQUATIONS PERTAINING TO REACTION KINETICS). K.W.Böer and S.Oberländer.

Z. Naturforsch., Vol. 13a, No. 4, 351-2 (April, 1958). In German.
The extraordinary difficulties encountered in the evaluation of
experimental data, and thus parameters, relating to non-stationary
processes are avoided if, instead of considering the excitation (or
activation) as a given function of the time, its value is determined
experimentally and therefrom, by adroit choice of solutions of the
differential equations, finding the values of physically interesting
parameters. The method is illustrated by application to non-
stationary photoconduction.

W.Good

517.9 : 537.312.5

5295. A NOTE ON THE METHOD OF CONTROLLED ACTIVATION [GESTEUERTEN ANREGUNG] S.Oberländer.

Z. Naturforsch., Vol. 14a, No. 1, 91-2 (Jan., 1959). In German.

It is shown that one of the constants in the previously given
solution of a reaction kinetic problem (see preceding abstract) is in
fact related to the parameters of the problem.

J.M.Hough

ASTROPHYSICS

TELESCOPE DOUBLET. AUTOMATIC DESIGN. See

Abstr. 4417

522.24 : 535.317.6

522.6 : 535.33.07

5296. AN AURORAL SPECTROGRAPH.

K.C.Clark and G.J.Romick.
J. Opt. Soc. Amer., Vol. 49, No. 2, 141-5 (Feb., 1959).

High sensitivity to auroral H α , resolution in elevation angle
along a narrow band from horizon to horizon, and simplicity of
components are principal features of a new automatic auroral
spectrograph. Sky light reaches an all-sky convex mirror by way
of an external curved slot in the vertical plane, whose calculated
shape gives a flat image of uniform width. This slit image of
adjustable width is photographed from above by a standard 16 mm
camera with f/0.95 lens, the light having passed through a blazed
grating at minimum deviation. In this arrangement distortions in
the noncollimated beam and losses by reflection are kept low, and
slit adjustment to 25-A resolution enhances detection of the
broadened H α emission line. Satisfactory sensitivity to major
airglow lines, hydrogen, and auroral features is obtained in
successive 15 min exposures, representing an approximately
fivefold improvement in time resolution over that of the IGY patrol
spectrograph, with a consequent loss in spectral resolution.

522.6 : 621.396.946

5297. A RADIO-TELESCOPE FOR λ 11.5 cm (2600 Mc/s).

K.O.Kiepenheuer and H.H.Rabben.
Z. Astrophys., Vol. 42, No. 2, 120-9 (1957). In German.

A complete receiving system is described. The sensitivity
limit corresponds to an aerial temperature of 60°K and some
preliminary solar observations are discussed.

H.J.A.Chivers

522.6 : 535.33.072

5298. THE APPARATUS FUNCTIONS, GRATING GHOSTS AND
STRAY LIGHT FOR THE TWO NEW PLANE GRATINGS IN THE

GÖTTINGEN SOLAR SPECTROGRAPH. A.von Alvensleben.

Z. Astrophys., Vol. 43, No. 1, 63-84 (1957). In German.

Using a krypton lamp and pure isotope Hg¹⁹⁸ lamp, the apparatus
functions were measured for various spectral orders and wavelengths.
The main causes of systematic errors are discussed in detail. The
observed profiles are found to be a little broader than calculated
profiles, the difference being partly due to diffusion of light in the
photographic emulsion. Rowland's ghosts are determined in position
and strength and stray light measurements made throughout the
spectral range. Precautions against stray light are described.

R.W.Fish

522.614 : 535.247.4

5299. THE IRIS-DIAPHRAGM BENCH PHOTOMETER OF THE BASLE OBSERVATORY. W.Becker and C.Biber.

Z. Astrophys., Vol. 41, No. 1, 52-60 (1956). In German.

Optical and constructional details are given of a new photo-
electric microphotometer designed specifically for magnitude mea-
surements on photographic stellar images. The apparatus is cap-
able of measuring up to 300 images per hr with an accuracy of
 $\pm 0^m.02$.

D.R.Barber

523.11

5300. ON NUCLEON-ANTINUCLEON SYMMETRY IN COSMOLOGY. R.A.Alpher and R.Herman.

Science, Vol. 128, 904 (Oct. 17, 1958).

It has been suggested that cosmological models should embody
an initial nucleon-antinucleon symmetry and that the present ratio
of nucleons to antinucleons is the result of a statistical fluctuation.
Simple arguments are presented for evolutionary models which
appear to rule out this possibility in the development of the universe.

523.11 : 532.5 : 538.3

FORCE-FREE MAGNETIC FIELDS. See Abstr. 4842

523.152.3

5301. ON THE INTERPLANETARY GAS AND ITS MAGNETIC
FIELD. L.Block.

Ark. Fys., Vol. 14, Paper 15, 179-93 (1958).

Two different models of the interplanetary magnetic field have been proposed by Lüst and Schlüter (Abstr. 9902/1954), and by Alfvén (Abstr. 6592/1958). Lüst and Schlüter have only considered the interaction with the interplanetary gas, whereas Alfvén only considers cosmic ray and magnetic storm data. This paper critically examines both fields and a suggestion for a compromise between the two is made, so that all known physical phenomena of importance are considered. It is also shown that there are three independent arguments why the interplanetary gas density at the earth's orbit cannot be higher than about 0.1 cm^{-3} ; (1) cosmic ray data indicate that the gas co-rotates with the sun at the earth's orbit, and no magnetic field is able to maintain this if the density is higher; (2) beams denser than about 25 cm^{-3} should be seen in the corona according to Alfvén; (3) beams of a density of about 0.1 cm^{-3} seem to suffice for the production of moderate magnetic storms if the electric field theory is correct.

523.16

5302. ON THE COSMIC TURBULENCE. I. H.Nariai.

Sci. Rep. Tohoku Univ. First Ser., Vol. 39, No. 4, 213-35 (Feb., 1956).

Generalized Navier-Stokes equations in an expanding universe, set up for small fluid velocities, include a term interpreted as energy dissipation arising from cosmic expansion. The case of solenoidal velocity fields (quasi-incompressibility) is considered, and a general theory of homogeneous turbulence is developed. The discussion distinguishes between three types of cosmic turbulence according as cosmic energy dissipation is negligible, comparable or much greater than viscous dissipation. Temporal transition between the three types of turbulence is found to be inconsistent with the concept of similarity.

R.A. Newing

523.161

5303. ON THE LOW-VELOCITY INTERSTELLAR GAS. I.

K.Takakubo.

Publ. Astron. Soc. Japan, Vol. 10, No. 4, 176-86 (1958).

Absorption lines of low radial velocities are investigated with reference to the distribution of the line intensity. This distribution is explained by the presence of a cloud (or clouds) in the immediate neighbourhood of the sun, small clouds, which are distributed in the interstellar space at random, and large clouds of less frequency.

523.161

5304. ON THE LOW-VELOCITY INTERSTELLAR GAS. II.

K.Takakubo.

Publ. Astron. Soc. Japan, Vol. 10, No. 4, 187-200 (1958).

The interstellar K-lines of low radial velocities are investigated with reference to the distribution of the radial velocity and the relation between the line intensity and the distance. The observed distribution of radial velocity of the line is equally explained either by exponential or Gaussian distribution of the radial velocity of clouds. The mean value of the limit of resolution for the observation may be larger than that currently assumed. Some evidence is presented against the assumption of a uniform gaseous medium in the interstellar space. The equivalent width of the line increases proportionally with the distance, but is not thus affected by the saturation of the line. The constant of the proportionality varies according to the directions of the line of sight with respect to the spiral arm of the galaxy.

523.161

5305. THE INFLUENCE OF RADIATION PRESSURE ON THE

DYNAMICS OF INTERSTELLAR GRAINS. G.Contopoulos.

Z. Astrophys., Vol. 42, No. 1, 7-33 (1957). In German.

523.161 : 539.18

METASTABILITY OF 2s STATES OF INTERSTELLAR HYDROGEN ATOMS. See Abstr. 5092

523.162

5306. SEPARATION OF DUST AND GAS IN INTERSTELLAR

CLOUDS. T.Schmidt.

Z. Astrophys., Vol. 40, No. 3, 199-216 (1956). In German.

The radiation pressure of very luminous stars exerted on dust particles in an approximately spherical interstellar gas cloud leads to partial segregation of gas and dust and to comet-like dust clouds which are sometimes observed. The main part of the cloud is accelerated to a velocity of only a few km/sec. The reaction which the dust grains suffer by partial sublimation seems to be insignificant in comparison with the acceleration by radiation pressure. Clouds in which the dust component predominates are dispersed. The time scale of the process is about 10^6 years; for comparison the luminosity of an average O 5 star is found to decline by a factor $1/e$ in about 5×10^5 years.

523.164 : 621.396.9

5307. THE CONSTRUCTION OF A RADIO-INTERFEROMETER FOR THE LOCALIZATION OF EXTRA-TERRESTRIAL SOURCES, AND THE REGISTRATIONS OBTAINED IN THE CASE OF THE SUN AND OF ARTIFICIAL SATELLITES.

A.H.Guerra Vieira and L.Q.Orsini.

An. Acad. Brasil. Cienc., Vol. 30, No. 3, 299-306 (1958).

In Portuguese.

The interferometer, for 108 Mc/s, consists of two pairs of aerials, one along the N-S, the other along the E-W direction.

Each aerial consists of two nets of eight half-wave dipoles. Using the data collected by this apparatus, the elements of the orbit of the satellite 1958 α were calculated.

L.Pincherle

523.164.31

5308. THE POLARIZATION OF SOLAR RADIO EMISSION AT A FREQUENCY OF 200 MHz. F.R.Neubauer and A.D.Fokker.

P.T.T.-Bedrijf, Vol. 8, No. 4, 177-94 (Sept., 1958).

523.164.32

5309. CALCULATION OF THE CENTRE-EDGE VARIATIONS AND OF THE ONE-DIMENSIONAL INTENSITY PROFILES AT $\lambda = 20 \text{ CM}$ AND $\lambda = 60 \text{ CM}$ FOR A ROTATION-SYMMETRICAL CONSTANT-TEMPERATURE CORONA MODEL. G.Wallis.

Z. Naturforsch., Vol. 12a, No. 4, 337-45 (1957). In German.

The variations were calculated for a special corona model

(Waldmeier, Abstr. 5617/1956) under assumption of isothermicity,

once in the pole and equator direction, and another time along a

family of straight lines parallel to both main axes of elliptical dis-

tribution; the selected temperature of the corona was 0.5 or

$1.5 \times 10^6 \text{ }^\circ\text{K}$. Graphical integration of the variation functions yielded

the line integrals of the radiation intensity for the same family of

lines. These integrals correspond with the corrected "one-dimen-

sional intensity profiles".

F.Lachman

523.164.42

5310. THE DETERMINATION OF THE LONGITUDES OF SOURCES OF EMISSION OF RADIO NOISE ON JUPITER. B.M.Peek

J. Brit. Astron. Assoc., Vol. 69, No. 2, 70-9 (Feb., 1959).

523.164.8

5311. THE REFLECTION OF RADAR SIGNALS FROM THE SUN.

F.G.Bass and S.Ya.Braude.

Bul. Inst. Politeh. Iasi, Vol. IV(VIII), No. 1-2, 127-33 (1958).

In Russian.

Considers the possibility of solar location. It is assumed that

the sun scatters the incident electromagnetic radiation like a rough

surface. The spectral composition change of the scattered radiation

due to the Doppler effect arising from the sun's rotation is taken

into account. If 30 Mc/s pulses are transmitted at 250 kW, using

an aerial whose gain is 3000, the power ratio of the signal reflected

by the sun and received on the earth to the solar and galactic noises

is of the order of unity.

523.165

5312. COSMIC RAY ORBITS IN INTERPLANETARY MAGNETIC FIELDS. L.Block.

Ark. Fys., Vol. 14, Paper 14, 161-78 (1958).

An interplanetary magnetic field, which should agree with ob-

served cosmic ray and magnetic storm effects, was suggested by

Alfvén (Abstr. 6592/1958). This field is worked out more in detail

in the present paper, and several cosmic-ray orbits are calculated

in this field. The results are briefly discussed and compared with

cosmic-ray observations. A beam field of $30 \mu\text{G}$ at the earth's orbit

is assumed, and, according to Venkatesan's analysis of Forbush de-

creases, the beam fields may vary from a few to about $100 \mu\text{G}$.

523.4 : 538.566.3

ABSORPTION OF MICROWAVES IN PLANETARY ATMOSPHERES. See Abstr. 4857

523.51

5313. ON THE URANIUM CONTENT OF STONE METEORITES AND THEIR "AGE". F.Hernegger and H.Wänke.

Z.Naturforsch., Vol. 12a, No. 10, 759-62 (1957). In German.

By neutron activation analysis three Chondrite samples have

been studied and the concentration is about 10^{-8} . The concentration

of barium was also measured and gave a mean value of $3.5 \times 10^{-6} \text{ g}$

Ba/g. For two samples helium concentration measurements have

enabled an age of 3.6 and 3.8×10^8 years respectively to be assigned.

J.M.Hough

5314. ON THE ACTION OF HIGH ENERGY PARTICLES ON IRON METEORITES. K.H.Ebert and H.Wänke.
Z. Naturforsch., Vol. 12a, No. 10, 766-73 (1957). In German.
By consideration of the mode of interaction it is suggested that the particular meteorite studied (Mt. Ayliff) spent 920 million years in the field of high energy particles.
J.M.Hough

523.51 : 539.17

5315. HELIUM AND NEON AS REACTION PRODUCTS OF HIGH ENERGY PARTICLES IN IRON METEORITES.
H.Wänke and H.Hintenberger.
Z. Naturforsch., Vol. 13a, No. 10, 895-7 (Oct., 1958). In German.
The isotope ratio for five different meteorites is determined for neon.
J.M.Hough

523.51

5316. ON THE FREQUENCY DISTRIBUTION OF THE ELEMENTS OF ORBIT FOR INTERPLANETARY DUST PARTICLES. U.Haug.
Z. Astrophys., Vol. 44, No. 2, 71-97 (1958). In German.
The space density of dust particles, and the rate of capture of particles by the earth, are expressed as integrals involving the frequency distribution $N(a,e,i)$ of the elements of particle orbits for an axisymmetric distribution of particles around the sun. Observations of zodiacal-light material and of meteors, together with simplifying assumptions concerning the analytical form of the function $N(a,e,i)$, are used to derive information concerning the frequency distribution of particle orbit elements.
R.A.Newing

523.7

5317. PROGRAMME OF IGY SOLAR OBSERVATIONS IN INDIA.
J. sci. industr. Res., Vol. 17A, No. 12(Suppl.), 68-9 (Dec., 1958).

523.74

5318. A THREE-STREAM MODEL OF THE SOLAR PHOTOSPHERE, AND LINE ASYMMETRY OF THE INFRARED OXYGEN TRIPLET. H.L.Voigt.
Z. Astrophys., Vol. 40, No. 3, 157-90 (1956). In German.
To account for the observed asymmetry of the violet and red half-widths of the OI lines at 7772, 7774, 7775 Å in high dispersion (0.2 Å/mm) spectra of the centre of the solar disk, use is made, in a modified form, of the three-stream model proposed by Bohm (1954). Here it is assumed that the photospheric temperature inequalities decrease with height, and that the Doppler shifts in the cool (descending), hot (ascending), and equilibrated gas streams also vary with optical depth. Computed values of half-widths, based on a stream velocity of 3 km/sec, give a violet/red asymmetry in good agreement with the observed value of ~9% at the centre of the solar disk.
D.R.Barber

523.742

5319. THE SOLAR LIMB DARKENING AT 4674 Å, AND THE DISTRIBUTION OF TEMPERATURE IN THE OUTERMOST PHOTOSPHERIC LAYERS. H.Neckel.
Z. Astrophys., Vol. 44, No. 3, 153-9 (1958). In German.
From the results of photometric observations at 4674 Å made during the partial eclipse of 30 June 1954 it is concluded that, near the solar limb ($\sin \theta > 0.98$) and within the range of optical depth, 0.05-0.10, there is a steep fall of temperature to a limiting value of between 3500° and 3600° K. (See also following abstract).
D.R.Barber

523.742

5320. THE TEMPERATURE DISTRIBUTION IN THE SOLAR PHOTOSPHERE FROM RESIDUAL INTENSITIES OF FRAUNHOFER LINES. H.Neckel.
Z. Astrophys., Vol. 44, No. 3, 160-8 (1958). In German.
Using intensity measures of selected Fraunhofer lines with known relative gf-values, it is shown that a negative temperature gradient exists in the outermost photospheric zone ($\log \tau \approx -5$), the boundary temperature being ~3600° K. (See also preceding abstract).
D.R.Barber

523.746 : 551.510.535

DETERMINING THE CORRELATION BETWEEN f_0F_2 AND SUNSPOT NUMBER. See Abstr. 5274

523.75

5321. THE POLAR PROMINENCE ZONE. M.Waldmeier.
Z. Astrophys., Vol. 42, No. 1, 34-41 (1957). In German.
During a typical 11-yr cycle of sunspot activity, the polar zone of prominences moves from 45° lat. (at s.s. min.) to the poles

(at s.s. max.), the rate of this migration being independent of the actual level of solar activity. A close connection exists between the long coronal streamers, and quiescent prominences, the maximum-type corona occurring when the heliographic latitude of the polar prominence zone is 69°.
D.R.Barber

523.75 : 537.568

H₂ FORMATION IN PROMINENCES. See Abstr. 4755

523.75 : 537.591.5

COSMIC-RAY INCREASES ASSOCIATED WITH SOLAR FLARES. See Abstr. 4770

523.752

5322. EXPERIMENTS WITH A LYOT H α -FILTER AND PRELIMINARY RESULTS ON THE STRUCTURE OF THE CHROMOSPHERE. K.O.Kiepenheuer.
Z. Astrophys., Vol. 42, No. 4, 209-27 (1957). In German.
Describes a solar cinematograph located on the island of Capri and equipped with a Lyot H α -filter of 0.6 Å bandwidth and photoelectric guiding. By its use, new information about the spatial structure of the chromosphere was obtained.

523.752

5323. A THEORY OF SOLAR PROMINENCES. R.Kippenhahn and A.Schlüter.
Z. Astrophys., Vol. 43, No. 1, 36-62 (1957). In German.
A theory of the stationary support of solar filaments (prominences) by the magnetic field of Babcock's field patches is proposed. Only at those places where the magnetic field is horizontal can a filament be supported. In addition, conditions of stability have to be fulfilled. Some simple two-dimensional models of this kind are considered, and necessary stability conditions corresponding to a lateral displacement of the filament as a whole are derived. The theoretically derived structure and density of the filaments is found to be in satisfactory agreement with observations, only the thickness resulting being smaller than the usually quoted value, which, however, represents only an upper limit. Some remarks are made concerning a theory of the sudden disappearances ("catapult theory") and this theory is compared with the theory of corpuscular emission ("melon seed theory") proposed earlier.

523.755

5324. THE IONIZATION BALANCE OF THE SOLAR CORONA, AND THE ORIGIN OF THE YELLOW CORONAL LINE. G.Elwert.
Z. Astrophys., Vol. 44, No. 2, 112-25 (1958). In German.
From a quantitative discussion of the ionization mechanism operating in the inner corona it follows that the 5694 Å line must originate in the hotter condensations ($T \approx 3 \times 10^6$ °K), whereas both red and green coronal lines are emitted from the surrounding cooler shells.
D.R.Barber

523.76

5325. AN EXPLANATION OF THE CORONAL POLAR STREAMERS AS LINES OF MAGNETIC FORCE. H.Bachmann.
Z. Astrophys., Vol. 44, No. 1, 56-63 (1957). In German.
Observed directions of the polar streamers in the coronal pattern at sunspot minimum (1954) are in good agreement with those of the magnetic field of a dipole whose axis coincides with that of the sun, and whose poles are at distances of ~0.6 solar radius (from the solar centre). This field can be produced by two circular currents, one in each hemisphere, with their planes lying at ~0.5 solar radius. A similar explanation apparently fails to account for the equatorial streamer pattern.
D.R.Barber

523.775 : 537.531 : 551.510.535

5326. X-RAYS ASSOCIATED WITH CORONAL CONDENSATIONS. G.Elwert.
Z. Astrophys., Vol. 41, No. 2, 67-83 (1956). In German.
Using the coronal model of Waldmeier and Müller (1950) in conjunction with radio measurements at cm- and dm-wavelengths, it is inferred that the radiation spectrum from coronal condensations shows a significant increase of flux for wavelengths below 30 Å, together with a shortwave cut-off around 6-7 Å. This result agrees with data derived from recent rocket flights. The effects of the X-radiation on the ionosphere are discussed, as are also the production of rays of wavelength 1-2 Å by K-electrons ejected from the active coronal regions. This ultra-shortwave radiation is believed responsible for the Mögel-Dellinger radio fade-outs.
D.R.Barber

- 523.84
5327. DETERMINATION OF THE RADIUS RATIO IN THE CASE OF OCCULTATION VARIABLES. K.F.d'Occhieppo. S.B. Österr. Akad. Wiss. mat.-nat. Kl. Abt. II, Vol. 165, No. 1-4, 1-39 (1956). In German.
The method developed by Schneller [Veröffentlichungen der Sternwarte Sonneberg, Vol. 1, No. 4 (1949)] for the determination of the system constants of occultation variables under assumption of uniformly bright stellar discs, is extended to cases in which stars have various degrees of marginal darkening; the auxiliary tables for this purpose are appended. By means of a simple method the most probable degree of marginal darkening is evaluated simultaneously with the determination of the radius ratio. F.Lachman
- 523.852 : 533.15
5328. THERMAL DIFFUSION IN GASEOUS NEBULAE. L.H.Aller and S.Chapman. Astrophys. J., Vol. 127, 797 (May, 1958).
- 523.877
5329. GAS MOVEMENTS IN THE LONG-PERIOD VARIABLES. I-II. C.E.R.Bruce. Observatory, Vol. 77, 107-8 (June); 153-4 (Aug., 1957).
It is shown that the gas velocities observed in the long-period variables and in a combination-spectra star, Δ Persei, are in accord with those to be expected on the electrical discharge theory of the outbursts in these stars (Abstr. 9382/1955 and 1033/1957). In any one star, e.g. χ Cyg, the different velocities associated with spectrum lines of different energies are similarly accounted for by the theory.
- 523.877
5330. STELLAR MODELS WITH ISOTHERMAL CORES AND INTERMEDIATE CONVECTIVE ZONES. I. Z.Hitotuyanagi and K.Suda. Publ. Astron. Soc. Japan, Vol. 9, No. 1, 7-15 (1957).
- 523.877
5331. STELLAR MODELS WITH ISOTHERMAL CORES AND INTERMEDIATE CONVECTIVE ZONES. II. Z.Hitotuyanagi and K.Suda. Publ. Astron. Soc. Japan, Vol. 10, No. 1, 8-25 (1958).
Stellar models consisting of isothermal cores exhausted of hydrogen and convective zones with intermediate hydrogen content surrounded by hydrogen-rich radiative envelopes are constructed. Six sequences of models with specified values of $\log C$ are computed for a fixed ratio of molecular weight of the core to that of the envelope. Mathematical characteristics and physical quantities are given as functions of two independent parameters taken as $\log C$ and the hydrogen in convective zones. The regions in the Hertzsprung-Russell diagram occupied by possible evolutionary tracks are also discussed. It is shown that a star evolving after the present models has a tendency to reach the Schönberg-Chandrasekhar sequence at the final stage of evolution.
- 523.877
5332. INHIBITION OF CONVECTION BY A MAGNETIC FIELD. M.Makita. Publ. Astron. Soc. Japan, Vol. 10, No. 1, 1-7 (1958).
The stability of a stellar atmosphere in the presence of a magnetic field is considered using the usual hydromagnetic equations. It is assumed that initially the magnetic field is homogeneous and that the atmosphere is hydrostatic. The extended Walén's criterion is derived neglecting disturbances of a higher order than the second. The criterion is applied to the solar convection zone, and a value of 200 gauss is obtained for the magnetic field strength of penumbra.
- 523.877
5333. NON-ADIABATIC PULSATIONS OF A STELLAR MODEL. P.Lal and P.L.Bhatnagar. Z.Astrophys., Vol. 41, No. 1, 21-34 (1956).
Using a method due to Rosseland, a second-order solution of the non-adiabatic equation is found in terms of a series of characteristic functions of the corresponding adiabatic equation. Hence, the period of the fundamental mode and the relaxation time are estimated for a model computed by Eddington ($M = 5.02$ solar masses, $R = 16.38$ solar radii, mean molecular weight = 2.2, opacity coefficient = $3.47 \times 10^{25} \text{ g}^{-1} \text{ cm}^2$). The period is increased from the adiabatic case by 0.007% and there is an exponential increase of amplitude with relaxation time about 1000 years. The first order approximation gives a decrease of period of 0.01% and a decrease of amplitude with relaxation time of about 3000 years. These results suggest that the departure from adiabatic conditions needs to be taken into account more precisely than in the present note. G.A.Chisnall
- 523.877
5334. TRANSFORMATION OF ELEMENTS AS A CONSEQUENCE OF NUCLEAR REACTIONS IN THE SURFACES OF ACTIVE STARS. L.Biermann. Z.Astrophys., Vol. 41, No. 1, 46-51 (1956). In German.
Fowler et al [Astrophys. J. Suppl., Vol. 1, No. 2, 167-94 (1955)] suggested that the anomalous over-abundances of some heavy elements in magnetic Ap stars may be explained by acceleration processes leading to element synthesis in relatively deep layers of the stellar atmosphere. Attention is drawn here to certain difficulties associated with this theory, and the possibility is examined of element formation in higher layers of the atmosphere. The effectiveness of the mechanism is found to be strongly limited, and an appreciable influence on the chemical composition of surface layers would follow only from a combination of many special conditions. R.A.Newing
- 523.877
5335. OBSERVATIONS ON PULSATING STARS. II. ESTIMATION OF THE TRUE PULSATION VELOCITY FROM MEASUREMENTS OF THE RADIAL VELOCITY. G.Thiessen. Z. Astrophys., Vol. 41, No. 4, 259-70 (1957). In German.
For Pt I, see Abstr. 5663 (1956). The necessary correction factor for the variable component of the radial velocity, whereby the true pulsation velocity is obtained, is strongly dependent on the mechanism of line broadening (rotation; isotropic, radial and transverse macroturbulence). Since this mechanism is not known, no reliable correction factor can be derived for the lowest point of the absorption line profile. The true pulsation velocity can be found and Baade's pulsation criterion proved only by determining the centres of gravity of the line profiles, since the positions of these centres are independent of the mechanism of line broadening. The correction factor for the line centres is only slightly dependent on the limb darkening. By a detailed study of line profiles, particularly of their lowest points, different line broadening mechanisms in pulsating stars can be distinguished for the first time. The almost identical lines arising from the various broadening mechanisms are split by the pulsation velocity into considerably different profiles.
- 525.3
5336. OBSERVATIONS OF ARTIFICIAL SATELLITES AT MEUDON OBSERVATORY. M.P.Muller. Bull. astron. (Paris), Vol. 22, No. 3, 155-70 (1959). In French.
Description of the apparatus and methods used for artificial earth satellites tracking. An example is given of a set of observations made during one passage, together with reduction and results. Periods of revolution for 1958 δ_1 are deduced from the Meudon observations.
- 525.3
5337. THEORY OF THE EFFECT OF DRAG ON THE ORBITAL INCLINATION OF AN EARTH SATELLITE. J.P.Vinti. J. Res. Nat. Bur. Stand., Vol. 62, No. 2, 79-88 (Feb., 1959).
It is assumed that the drag is in the direction of the air velocity relative to the satellite and that its magnitude diminishes so rapidly with altitude that it is appreciable only near perigee in an elliptic orbit. Without further assumptions about the properties of the drag function, results are then deduced for the secular changes in inclination up to, but not including, the final ballistic stage of motion.
- 525.3 : 551.513
5338. CHANGES IN THE INCLINATION OF SATELLITE ORBITS TO THE EQUATOR. R.H.Mersoni, D.G.King-Hele and R.N.A.Plimmer. Nature (London), Vol. 183, 239-40 (Jan. 24, 1959).
The suggestion made recently that changes in the orbital inclination of earth satellite 1957 β could be caused by rotation of the atmosphere is confirmed by a more rigorous analytical treatment of the observational data, taking into consideration the spread of atmospheric drag values around perigee. The conclusion is also supported by the independent analysis of Bosanquet (Abstr. 1012/1959). D.R.Barber
- 525.3 : 531.539
5339. ON THE BEHAVIOUR, ACCORDING TO NEWTONIAN THEORY, OF A PLUMB LINE OR PENDULUM ATTACHED TO AN ARTIFICIAL SATELLITE. J.L.Syngé. Proc. Roy. Irish Acad. A, Vol. 60, No. 1, 1-6 (Jan., 1959).

5340. ON THE MOTION OF A CERTAIN CLOSE [ARTIFICIAL EARTH] SATELLITE. Y.Kozai.
 Publ. Astron. Soc. Japan, Vol. 10, No. 1, 40-7 (1958).

Develops a theory of secular perturbations of a satellite moving under a gravitational field of a spheroidal mother planet, when the orbital plane makes an arbitrary inclination γ . It is shown that the inclination of the orbital plane of the satellite is nearly constant and that the motion of the node is uniform and retrograde, unless the

eccentricity is small. However, the value of the eccentricity and the velocity of the argument of perigee, which is always positive, vary periodically. When the inclination is greater than γ_0 ($\sin \gamma_0 = \sqrt{8/19}$), the motion develops Poincaré instability. But even in this case the motion is not so complicated, and the main difference from that in the former case is that the velocity of the argument of perigee may take both the positive and the negative values as a function of the argument of perigee. An expression for the secular motion of the node up to the terms of the second order is obtained.

PHYSICS

GENERAL

5341. ON EXPLANATIONS OF ELECTRIC AND MAGNETIC CONSTANTS AND UNITS. A.T.Gresky.
 J. Franklin Inst., Vol. 267, No. 3, 201-10 (March, 1959).
 53.081 : 537.081 : 538.081
- Employing dimensional methods, it is suggested that "explanations" of the free-space dielectric constant ϵ and the magnetic permeability constant μ may lie in their proposed relationships to four highly fundamental quantities; for example, $\epsilon_g = m_e^2 (\hbar \alpha_{ec})^{-1}$ and $\mu_g = \hbar \alpha_e (m_e^2 c)^{-1}$. The latter is considered to reflect a specific intrinsic property of the electron, that is, a constancy in the ratio of its magnetic moment (Bohr magneton) to its spin ($\hbar/2$). The former, equal to $1/\mu_g c^2$, reflects an additional intrinsic relationship of the electron to light velocity, presumably a characteristic of its associated photons. Other constants and units are similarly analysed to suggest possible methods for understanding the submicroscopic nature of electric and magnetic phenomena.

5342. PREDICTABILITY IN CLASSICAL MECHANICS. M.Born.
 Z. Phys., Vol. 153, No. 3, 372-88 (1958). In German.
 530.1 : 531

The aim of this paper is mainly philosophical: to expose a fundamental misconception in the persistent attempts at "saving" determinism in quantum mechanics (e.g. with the help of hidden parameters). Starting from the view that already in classical mechanics it is unrealistic, and therefore erroneous, to consider exactly known initial states, the problem of the relation between an initial and a final distribution is studied on the classical theory. In particular: is it possible to make a unique prediction if the limit of zero initial mean deviation is taken last? — the author's criterion for determinism. It is shown that, except for systems of ideal harmonic oscillators, this is not the case. W.A.Hepner

GRAVITATION . RELATIVITY

5343. GRAVITATIONAL PROPERTIES OF ANTIMATTER. L.I.Schiff.
 Proc. Nat. Acad. Sci. U.S.A., Vol. 45, No. 1, 69-80 (Jan., 1959).
 Arguments are given for believing that all particles and antiparticles have positive inertial and passive gravitational masses, and that the principle of equivalence is valid to a high accuracy. Speculations are made about the active gravitational masses of antiparticles. G.Stephenson
 530.12

5344. NEW RESEARCH ON OLD GRAVITATION. R.H.Dicke.
 Science, Vol. 129, 621-4 (March 6, 1959).
 Review article. Possible dependence of physical constants on the position, epoch, and velocity of the laboratory.

5345. QUANTUM THEORY OF GRAVITATION: GENERAL FORMULATION AND LINEARIZED THEORY. R.Arnowitz and S.Deser.

Phys. Rev., Vol. 113, No. 2, 745-50 (Jan. 15, 1959).
 530.12

The problem of quantizing general relativity using the Schwinger action principle is considered. The advantages of this technique are discussed and the general formulation of the action principle using the Palatini Lagrangian is given. The difficulty in quantizing general relativity is due to the constraint equations. Two types of constraints are distinguished: algebraic constraint equations and differential constraint equations. The former may be dealt with trivially in this formalism. The latter arise due to the presence of function-type ("gauge") group invariances. In order to eliminate these variables one must make use of the group transformations themselves. Thus in general relativity the transformation from the full set of variables to the independent canonical ones is a coordinate transformation. The linearized theory is treated in detail from this viewpoint and the full theory is briefly discussed.

5346. RIGOROUS SOLUTION OF EINSTEIN'S UNIFIED THEORY FOR A SPECIAL TYPE OF SYMMETRY. J.R.Rao.
 Acta phys. Austriaca, Vol. 12, No. 3, 251-61 (1959).
 530.12

Solution of the field equations in the "weaker form" (with certain restrictions) is obtained, corresponding to the infinite plane of the general relativity with both electric and magnetic fields present.

5347. MEASUREMENT OF TIME AND RELATIVITY. O.Costa de Beauregard.
 Cahiers de Phys., Vol. 12, 256-60 (July, 1958). In French.
 The theoretical connection between experiments associated with "ether drift", optical metrology, hertzian chronometry and the measurement of the velocity of light is discussed in the light of relativity and quantum mechanics. T.R.Carson
 530.12

5348. COVARIANT CONSERVATION LAWS IN GENERAL RELATIVITY. A.Komar.
 Phys. Rev., Vol. 113, No. 3, 934-6 (Feb. 1, 1959).
 530.12

A set of covariant conservation laws is constructed in the general theory of relativity. Their relationship to the generators of infinitesimal coordinate transformations is indicated. In a given coordinate system certain of these quantities may be naturally identified as energy and momentum. We can continue to recognize these conserved quantities in all coordinate systems due to the covariant character of the expressions.

5349. UNITARY IRREDUCIBLE REPRESENTATIONS OF THE LORENTZ GROUP. C.Fronsdal.
 Phys. Rev., Vol. 113, No. 5, 1367-74 (March 1, 1959).
 530.12
- The unitary irreducible representations of the inhomogeneous, proper Lorentz group are determined, using a prescription given by Wigner, with special emphasis on the case of zero rest mass. The principal results are: (a) the construction of one-component representations for the case of zero mass and discrete spin; (b) the existence of a Foldy-Wouthuysen transformation for zero mass and spin $\frac{1}{2}$; (c) the construction of "position operators" for zero mass and spins $\frac{1}{2}$, 1; (d) the complete synthesis of the Dirac, Majorana, and Maxwell one-particle theories.

5350. TWO BODIES AT REST IN GENERAL RELATIVITY. L.Marder.
Proc. Cambridge Phil. Soc., Vol. 55, Pt 1, 82-6 (Jan., 1959).
There is no static axisymmetric two-body solution of Einstein's gravitational field equations, if it is assumed that the bodies are separated in a certain definite sense. It is shown, by the construction of a complete physically sensible model, that static two-body solutions do exist for systems in which one body is hollow and contains the other. The stability of the particular system described is briefly discussed.

FIELD THEORY . QUANTUM THEORY

5351. THE CONCEPT OF ORDER. IV. QUANTUM MECHANICS. E.W.Bastin and C.W.Kilmister.
Proc. Cambridge Phil. Soc., Vol. 55, Pt 1, 66-81 (Jan., 1959).
For Pt III, see Abstr. 3686 (1958). Quantum mechanics is formulated in terms of the sequences introduced in Pt I-III. This reformulation resolves some difficulties in the foundations of quantum theory and gives a new picture of an elementary particle. There are three sections: (1) Explanation of the existence of particles with an exhaustible set of attributes by means of these sequences. (2) Demonstration that these particles are actually the elementary particles of quantum theory, by showing the isomorphism of a well-known form of quantum mechanics with the mathematics of sequences, except for the scale-constant in the former. (3) Explanation of the existence of the scale-constant and the connection of its finiteness with the finiteness of the velocity of light.
5352. INTERPRETATION OF AN "ANOMALOUS" REPRESENTATION OF THE INVERSION GROUP. G.A.Sokolik.
Zh. eksper. teor. Fiz., Vol. 33, No. 6(12), 1515-16 (1957). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 6(33), No. 6, 1170-1 (June, 1958).
For the "anomalous" representations of space and time inversion see Gel'fand and Tsetlin (Abstr. 6589/1957). The interpretation given is in terms of a 5-dimensional Lorentz group. J.C.Taylor

5353. ELECTROMAGNETIC INTERACTION WITH PARITY VIOLATION. Ya.B.Zel'dovich.
Zh. eksper. teor. Fiz., Vol. 33, No. 6(12), 1531-3 (1957). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 6(33), No. 6, 1184-6 (June, 1958).
The interaction $\sigma \cdot \text{curl } H$ violates parity, yet is gauge invariant. It is really a direct interaction between currents. A physical picture of it is described. J.C.Taylor

5354. ENERGY-MOMENTUM TENSOR FOR ELECTROMAGNETIC FIELDS. See Abstr. 4829

5354. INTERACTION BETWEEN FIELDS AND QUANTUM RELATIONS. N.V.Mitskevich.
C.R. Acad. Bulg. Sci., Vol. 11, No. 5, 367-70 (Sept.-Oct., 1958). In Russian.
The second quantization of fields is usually based on the transformational properties of their wave-functions under infinitesimal transformations of the coordinates. It is therefore connected with the conserved quantities of the type of the energy momentum and angular momentum. Thus there is a connection between this formalism and that with gravitational interaction, also caused by energy and momentum. Here emphasis is given to the role of the canonical quasitensor in the establishment of commutational relations. It is found that the generalized (without antisymmetrization) angular momentum introduced in a previous paper (Abstr. 7709/1958) can be successfully used in the quantum theory as well. All results obtained do not suppose any weakness or absence of interactions between the fields.

5355. A PARTICULAR INTEGRAL REPRESENTATION OF THE FUNCTION $\Delta_4^{(+)}(\xi; a)$. E.Montaldi.
Nuovo Cimento, Vol. 11, No. 1, 149-52 (Jan. 1, 1959). In Italian.
The functions occur in the theory of vacuum expectation values for scalar fields. See also Abstr. 901 (1956). R.A.Newing

5356. THE INVARIANCE OF MASS-REVERSAL AND THE FORM OF THE INTERACTIONS. T.Takabayasi and V.V.Raman.
C.R. Acad. Sci. (Paris), Vol. 247, No. 25, 2307-10 (Dec. 22, 1958). In French.
The hypothesis of invariance with respect to mass-reversal — defined in the usual way — and with respect to time-reversal, leads to all the known interactions between the "elementary particles", some of which conserve parity and some of which do not. P.K.Kabir

5357. UNIVERSAL BARYON-MESON COUPLING. R.E.Behrends.
Nuovo Cimento, Vol. 11, No. 3, 424-7 (Feb., 1959).
A universal baryon-meson coupling which allows for only those particles which are presently known to exist and which depends upon only one bare coupling constant is discussed.

5358. WEAK AND ELECTROMAGNETIC INTERACTIONS. A.Salam and J.C.Ward.
Nuovo Cimento, Vol. 11, No. 4, 568-77 (Feb. 16, 1959).
The postulate of a "local connection" in a [3] charge space leads to the introduction of three spin one fields. One of these can be identified with the electromagnetic field and the other two can be shown to mediate all known weak interactions, thus unifying these interactions with electromagnetism. The theory takes account of the fact that weak interactions violate parity and strangeness conservation while electromagnetic interactions do not do so.

5359. FERMI INTERACTION CAUSED BY INTERMEDIARY CHIRAL BOSON. Y.Tanikawa and S.Watanabe.
Phys. Rev., Vol. 113, No. 5, 1344-53 (March 1, 1959).
The Fermi interaction is interpreted as a nonlocal interaction resulting from a double Yukawa-type interaction in which the intervening boson has a definite chirality. The theory is quantizable and renormalizable, and in the "local" limit, the results agree with the usual (V-A) theory of the direct Fermi interaction. The general framework of the theory not only gives a basis for the existence of parity-nonconserving interactions, but also determines the allowed forms of such interactions. The nonlocal effect of the intervening boson propagator tends to give an improved agreement with experiments.

5360. CONSEQUENCES OF RENORMALIZABLE WEAK INTERACTIONS. S.Oneda and Y.Tanikawa.
Phys. Rev., Vol. 113, No. 5, 1354-60 (March 1, 1959).
Consequences of the theory of renormalizable weak interactions caused by intermediary chiral bosons are further investigated with regard to the decay processes of the pion, K-meson, and hyperons. It is shown that all those aspects of weak couplings which can be satisfactorily explained in terms of the local Fermi interaction with V-A combination can be equally well reproduced by the present model. Furthermore, on account of the convergence of the present theory, the results of computations are less ambiguous than those obtained from the local Fermi interaction model. Finally some possible experimental tests of the theory, mainly by the use of the non-localizability of the lepton interactions inherent in this theory, are discussed.

5361. UNIVERSAL WEAK BOSON AND FERMION INTERACTION. M.Sugawara.
Phys. Rev., Vol. 113, No. 5, 1361-6 (March 1, 1959).
A modified interpretation of an idea of divergences currents due to Feynman and Gell-Mann is investigated in detail, in which some pairs of bosons (pions and K-mesons) are assumed to exist, besides fermion pairs, among members exerting a universal weak

interaction. In particular, the author proposes a pair consisting of a neutral K-meson and a charged pion, in addition to a pion pair and pairs of leptons, nucleons, and some hyperons. Strong evidence for this pion-K-meson pair is provided by its surprising fit to short-lived decay of neutral K-mesons. An essential presumption is here that pion-muon decay is consistent with the present scheme; its ratio to pion-electron decay is left unchanged. If a global symmetry of pion coupling to hyperons is further assumed, and the K-meson interaction is simply assumed as comparatively weaker, then the present scheme seems consistent with all known data on decays of strange particles as far as reliable estimation can be made. A complete scheme of universal weak interaction is not obtained uniquely, since there is no particular necessity for nor objection to some pairs of particles, from available theoretical and experimental information. Some decay modes which are as yet unobserved but are expected according to the present scheme, are summarized.

530.145

5362. THE 13-PARAMETRIC GROUP OF TRANSFORMATIONS OF THE SPINOR SPACE AND ITS REPRESENTATIONS.

J.Rzewuski.

Acta phys. Polon., Vol. 17, No. 6, 417-28 (1958).

The irreducible representations of a 13-parametric group of transformations of the spinor space are constructed. They include all transformation types so far assumed phenomenologically for the fundamental particles, including their isotopic spin characterization. An eight-dimensional real spinor space corresponding to the original four-dimensional complex spinor space is introduced. It is shown that the spinor space provides a common geometrical basis for all conservation laws (including charge, isotopic spin and baryon conservation laws). The possible bilinear connections of the spinor space with the conventional space-time are discussed. These connections enable one to introduce inversions and to derive the connection between the differential equations in both spaces.

530.145

5363. ON THE BILOCAL THEORY OF THE ELECTRON.

E.Minardi.

Acta phys. Polon., Vol. 17, No. 6, 429-33 (1958).

The bilocal theory presented in previous works (Abstr. 4815/1956 and 3953/1957) is developed in such a way that a Majorana neutrino, instead of an ordinary neutrino, is introduced in the zero approximation of the perturbation calculation for that part of the mass due to the virtual photons interacting with the internal part of the bilocal field. Moreover, the contribution to the mass due to photons which interact with the part of the bilocal field describing the observable motion is calculated. The total mass obtained with the above calculation agrees fairly accurately with the experimental mass of the electron if the 2.30×10^{-13} cm value of the universal length is used.

530.145

5364. ON SPINOR WAVE EQUATIONS CONTAINING REFLECTION OPERATORS.

H.A.S.Eriksson.

Ark. Fys., Vol. 15, Paper 2, 31-2 (1959).

An example is given of a system of two first-order wave-equations containing a reflection operator. Applied to an electron in a Coulomb field, the ordinary fine structure formula is obtained.

530.145

5365. IRREDUCIBILITY CONSTRAINTS AND FIELD EQUATIONS FOR THE ELEMENTARY PARTICLES. I. BOSONS.

C.G.Bollini.

Nuovo Cimento, Vol. 11, No. 3, 342-50 (Feb. 1, 1959).

The conditions needed to describe an elementary particle by an irreducible quantity in the Lorentz group are taken as constraint equations to be imposed on the field entity. The independent components are extracted in a covariant way. The field equations are deduced from a Lagrangian in which only the free components are permitted to be varied. The commutation relations, compatible with the constraints, are also given. In this paper, the field entity is a tensor.

530.145

5366. G-CONJUGATION AND THE GROUP-SPACE OF THE PROPER LORENTZ GROUP.

E.J.Schremp.

Phys. Rev., Vol. 113, No. 3, 936-43 (Feb. 1, 1959).

An earlier proposal of the author for the incorporation of isotopic spin into the foundations of the theory of spin $\frac{1}{2}$ particles, based upon a consideration of the group-space of the proper Lorentz group, is here shown to require a certain definite conception of the essentially spatiotemporal character of all "internal" elementary

particle phenomena such as isotopic spin. It is further shown that according to this proposal the particular spatiotemporal character of the 3-parameter group of isotopic spin rotations of a strongly interacting charge doublet is identical with that of another 3-parameter group of spinor transformations recently applied by Pauli to the neutrino (Abstr. 8397/1957). It thus follows that for leptons in general there should exist an analogue of isotopic spin rotations, which must be expected to differ from the latter, however, in its physical interpretation. Through a similar generalization of the notion of G-conjugation, a fundamental criterion is then shown to be available for the classification of all spin $\frac{1}{2}$ particles into the two families of leptons and baryons, respectively.

530.145 : 539.12

5367. V-A FOUR-FERMION INTERACTION AND THE INTERMEDIATE CHARGED VECTOR MESON.

S.Oneda and J.C.Pati.

Phys. Rev. Letters, Vol. 2, No. 3, 125-7 (Feb. 1, 1959).

Gives consequences of this hypothesis for the spectrum in K_{e3} , $K_{\mu 3}$ and muon decay, and for the muon lifetime.

J.C.Taylor

530.145

5368. SOLUTIONS OF BHABHA'S EQUATION FOR A FREE PARTICLE.

F.E.Prieto.

Rev. Mexicana Fis., Vol. 6, No. 4, 165-84 (Oct., 1957). In Spanish.

Free particle solutions of Bhabha's equation are obtained for a particle with two different states of mass and spin. Of the 12 independent solutions, four correspond to states of spin $\frac{1}{2}$, and 8 correspond to states of spin $\frac{3}{2}$. The 20 component solutions are expressed as five-vectors and the components of these vectors are linear combinations of free particle solutions of Dirac's equation.

530.145

5369. THE BORN EXPANSION IN NON-RELATIVISTIC QUANTUM THEORY.

C.Zemach and A.Klein.

Nuovo Cimento, Vol. 10, No. 6, 1078-87 (Dec. 16, 1958).

Potential scattering of a non-relativistic particle is studied by means of the Born series for the Green's function, wave-function, and scattering amplitude. For a wide class of potentials, these series are proved to converge at sufficiently high incident energies. The validity of the Born approximation in the high energy limit is also shown.

530.145

5370. THE ASYMPTOTIC CONDITION FOR SIMPLE SCATTERING SYSTEMS.

J.M.Jauch and I.I.Zinnes.

Nuovo Cimento, Vol. 11, No. 4, 553-67 (Feb. 16, 1959).

Necessary and sufficient conditions are given for an interaction operator of a simple scattering system to admit a scattering operator. The result is applied to the study of radial scalar potentials.

530.145 : 539.14

5371. PERTURBATION THEORY FOR AN INFINITE MEDIUM OF FERMIONS.

A.Klein and R.Prange.

Phys. Rev., Vol. 112, No. 3, 994-1007 (Nov. 1, 1958).

The ground-state energy and low-energy excitations of single-particle character of an infinite medium of fermions are discussed with the aid of time-dependent Green's functions, which are convenient generalizations of the exact particle correlation functions in the ground state of N particles. The power series development for the one- and two-particle functions, under the restriction to two-body forces, is derived and described by means of Feynman diagrams. The derivation of the linked-cluster expansion for the energy then follows immediately. The equivalence to previous versions is established. The one-particle function is examined in particular detail, and it is shown that the poles of its space-time Fourier transform studied as a function of the energy variable, for fixed momentum, determined the (N+1)-particle and (N-1)-particle excited states which have single-particle character. For a reasonable assumption about the full spectrum of excited states, it is found that for the interacting system, single-particle excitations with a real energy occur only at the Fermi momentum. It is pointed out that the corresponding energy, termed the perturbed Fermi energy, equals the binding energy per particle in the ground state of N particles for a saturating system at equilibrium density. It is shown, finally, that the entire structure of the theory may be carried over to the case of finite temperature, requiring only a redefinition of the Green's functions. The analogy is constructed from a discussion of the internal energy.

5372. GENERALIZED REACTION MATRIX APPROACH TO THE THEORY OF THE INFINITE MEDIUM OF FERMIONS. R. Prange and A. Klein.
Phys. Rev., Vol. 112, No. 3, 1008-20 (Nov. 1, 1958).

A closed set of coupled, nonlinear integral equations is obtained which completely describe a system of Fermi particles. The equations define the one and two-particle Green's functions which are completely analogous to those used in the field theory of fundamental particles. Special boundary conditions appropriate to the infinite medium of fermions are employed. Approximations to these equations are made which lead to a generalized Brueckner reaction-matrix formalism in the case of nuclear matter and which lead to an expression for the correlation energy in the case of the electron gas. The approximations for the system of nuclear matter are of three types: ones which neglect the simultaneous interaction of three or more nucleons; the effective interactions of the vacant states below the Fermi sea; and the self-energy interactions with excited nucleons. The relationship between the reaction matrix and the expectation value of the actual potential energy is discussed. It is found that the energy levels given by the Brueckner formalism are nearly those given by a consideration of the actual energy, thus indicating that the shell-model energy levels for closed-shell-plus-one nuclei should be almost correct. A formula for the momentum distribution of nucleons in nuclear matter is obtained.

530.145 : 537.531.85

QUANTUM-MECHANICAL THEORY OF THE COMPTON SCATTERING OF X-RAYS. See Abstr. 4675

5373. DISCRETE STATES FOR NON SINGULAR AND SINGULAR POTENTIAL PROBLEMS. T. Tietz.
Nuovo Cimento, Vol. 11, No. 1, 126-30 (Jan. 1, 1959).

For the cases of the harmonic oscillator in one and three dimensions, the hydrogen atom, and an equation considered by Case (Abstr. 2393/1951) it is shown that correct eigenvalues and quadratically integrable eigenfunctions can be obtained from the condition that the Wronskian of the unbounded and the bounded solution vanishes.
W.A. Hepner

5374. APPLICATION OF LINEAR NETWORK ANALYSIS TO FEYNMAN DIAGRAMS. J. Mathews.
Phys. Rev., Vol. 113, No. 1, 381 (Jan. 1, 1959).

An analogy between a linear passive electrical network and a Feynman diagram is pointed out. The power dissipated in the network is closely related to the denominator of the Feynman matrix element, and this similarity provides a very simple proof of Nambu's results concerning the location of the singularities of Green's functions.

5375. THEORY OF MANY-BOSON SYSTEMS: PAIR THEORY. M. Girardeau and R. Arnowitt.
Phys. Rev., Vol. 113, No. 3, 755-61 (Feb. 1, 1959).

The many-boson system with repulsive interactions is treated by a variational method based on a variational trial state of an exponential pair-excitation type obtained by a generalization of that of Bogoliubov; the treatment is closely related to an intermediate-coupling approximation with respect to pairs. The non-linear integral equation which determines the variational ground state is derived, and various properties of this ground state and the associated excited states are examined. The resultant low-lying spectrum lies below that of Bogoliubov by an amount proportional to the total number of particles. The variational principle is shown to produce rigorous energy eigenvalue differences for the pair part of the Hamiltonian. The variational states, however, still exhibit unphysical features characteristic of pair-excitation states. The pair correlation function does not go to zero at zero particle separation and the phonon spectrum exhibits a gap above the ground state. It is suggested that these features can be removed by using states which take into account excitation of momentum-conserving groups of more than two particles.

5376. DYNAMICAL FEYNMAN'S THEOREM. E.H. Kerner.
Phys. Rev. Letters, Vol. 2, No. 4, 152-3 (Feb. 15, 1959).
Feynman's theorem (1939) is extended to apply to moving nuclei

and non-stationary electron states, the conservative force on a nucleus being separated into two non-conservative parts, the first classical and due to the nuclei, and the second a quantum part due to the electrons. An iterative calculation scheme is suggested.

J. Hawgood

5377. RADIATIVE CORRECTIONS IN THE DISPERSION RELATIONS FOR $\pi^\pm + p \rightarrow \pi^\pm + p$. V.K. Fedyanin.
Zh. eksper. teor. Fiz., Vol. 33, No. 5(11), 1301-3 (1957). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 6(33), No. 5, 1001-2 (May, 1958).

The one-nucleon-one-photon contribution to the dispersion integral is estimated by perturbation theory. This leads to a difference between the π^+ and π^- coupling constants of the order of 3%.

J.C. Taylor

5378. ON THE USE OF THE DISPERSION IN ENERGY AS A CRITERION FOR THE ACCURACY OF THE VARIATIONAL METHOD. D.P. Leper and D.S. Chernavskii.
Zh. eksper. teor. Fiz., Vol. 33, No. 5(11), 1311-12 (1957). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 6(33), No. 5, 1009-10 (May, 1958).

It is shown that the magnitude in error due to the inaccuracy of the trial functions can be estimated by using the dispersion in the energy of the trial functions.

P. Roman

5379. WAVE EQUATION FOR A FREE NUCLEON. Kh. Yiglane.
Zh. eksper. teor. Fiz., Vol. 33, No. 6(12), 1511-12 (1957). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 6(33), No. 6, 1167-8 (June, 1958).

The equation

$$[\Gamma^\nu \partial_\nu - \kappa I \exp(2a T_g)] \psi = 0$$

is proposed, where $\Gamma^\nu = \mathbf{1}_2 \times \gamma^\nu$, $T_k = \sigma_k \times \gamma^5$, $I = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \times \mathbf{1}_4$, with $\mathbf{1}_2$, $\mathbf{1}_4$ being the 2×2 and 4×4 unit matrix respectively. Further, $\kappa = m_0 c/\hbar$ and the constant a must be chosen to be $3\alpha/10\pi$, in order to obtain the correct proton and neutron mass.

P. Roman

5380. RETARDED PRODUCTS AND BOUND STATES. K. Baumann.

Z. Phys., Vol. 152, No. 4, 448-53 (1958). In German.

The properties of operator products which are retarded with respect to an arbitrary number of simultaneous arguments are studied. In perturbation theory, their vacuum expectation values can be described by a generalization of Dyson's doubled graphs, while general matrix elements can be expressed with the help of single-time irreducible doubled graphs and the single-time wave-functions of the bound states. The relation of these retarded products to the new Tamm-Dancoff equation is the same as that of the time-ordered products to the Bethe-Salpeter equation.

W.A. Hepner

SOLUTION OF THE SCHRÖDINGER EQUATION FOR
 $V(x) = -V_0 \operatorname{cosec}^2(\pi x/a)$. See Abstr. 5145

DISPERSION RELATIONS FOR THE $\pi + N \rightarrow \pi' + \pi'' + N'$ PROCESS IN THE FIXED-NUCLEON APPROXIMATION.
See Abstr. 4936

STATISTICAL MECHANICS TRANSFER PROCESSES

5381. INFORMATION CONTENT AND PHYSICAL SYSTEMS. L. Berger.

Helv. phys. Acta, Vol. 31, No. 2, 159-66 (1958). In French.

Shows how the notion of information content can be introduced to describe statistical correlations between physical systems. This problem is treated in both the classical case (systems which are characterized by c-numbers) and the quantum case (systems which are characterized by q-numbers). In both cases, the time evolution of information is investigated for an isolated system. A

conservation equation for information is derived. The definition and mathematical properties of information content are briefly given. A definition is chosen, which explicitly shows two elements on which information depends always; these elements are: the system which contains information ("document"), and the system described by the information ("subject").

530.162

5382. PROBLEMS OF COLLECTIVE MOTION IN PHYSICS.
D. ter Haar.

Nature (London), Vol. 183, 866-7 (March 28, 1959).

Summary of conference held at Birmingham on 2-3 Jan., 1959, sponsored by the Physical Society. Topics covered included gaseous plasmas, plasma problems in electron theory of metals, and liquid helium and superconductivity.

530.162

5383. A MONTE-CARLO METHOD TO CALCULATE MULTIPLE PHASE SPACE INTEGRALS. I. F.Cerulus and R.Hagedorn.
Nuovo Cimento Suppl., Vol. 9, No. 2, 646-58 (1958).

A method is described for calculating phase space integrals in such cases as collisions of high energy particles in which ~ 1 to 10 particles are created. The Monte Carlo method is used to investigate the distribution of energy among these particles. An advantage of the method is that the energy spectra of the emitted particles is also obtained. The accuracy ($\sim$ few %) is much better than that given by the method of repeated numerical convolution, when the circumstances are unfavourable.

A.Ashmore

530.162

5384. A MONTE-CARLO METHOD TO CALCULATE MULTIPLE PHASE SPACE INTEGRALS. II. F.Cerulus and R.Hagedorn.
Nuovo Cimento Suppl., Vol. 9, No. 2, 659-77 (1958).

A method is given for estimating the error of the calculation described in the preceding abstract. This error is the statistical one arising from the fact that the summation is over a finite number of energy distributions. The flow diagram used with the IBM 650 computer is given. Checks have been made for cases in which the phase space integral can be rigorously solved; e.g. for massless particles. The actual errors are within the limits of the estimated ones. Computing times are estimated for 8% accuracy. It is found that about an hour is needed for 5 particles, 100 hours for 10 particles.

A.Ashmore

530.162

5385. MANY-BODY PROBLEM IN QUANTUM STATISTICAL MECHANICS. I. GENERAL FORMULATION. T.D.Lee and C.N.Yang.
Phys. Rev., Vol. 113, No. 5, 1165-77 (March 1, 1959).

A formulation is given whereby the grand partition function of a many-body system satisfying Bose-Einstein or Fermi-Dirac statistics is expressed in terms of certain U functions defined for the same system with Boltzmann statistics. These U functions are then shown to be evaluable in successive approximations in terms of a binary kernel B which can be computed from a solution of the two-body problem. The approach to the limit of infinite volume is studied. The example of a hard sphere interaction is discussed in some detail.

530.162

5386. STATISTICAL MECHANICS OF STRINGS. N.L.Balazs.
Phys. Rev., Vol. 113, No. 5, 1178-80 (March 1, 1959).

In the usual statistical mechanical theory of strings the mean square potential energy of a string element is infinite. This is in contradiction with the assumption that the potential energy of a string element is small; this assumption is used to linearize the equations of motion. In this note, we show that the difficulty can be remedied if we take into account the finite thickness of the string, introducing thereby additional terms to the energy connected with bending.

530.162

5387. CLASSICAL FLUCTUATION-RELAXATION THEOREM.
R.H.Kraichnan.

Phys. Rev., Vol. 113, No. 5, 1181-2 (March 1, 1959).

A general expression is derived for the average infinitesimal-impulse-response matrix of a conservative classical system in a canonical ensemble. The equations of motion are taken as $\dot{x}_n = X_n$, where the X 's, as well as the energy E , are functions of the x 's but not of their time derivatives. The Liouville equation $\sum \partial \dot{x}_n / \partial x_n = 0$ is assumed, but it is not required that the equations of motion be derivable from a Hamiltonian. If they are, the x 's are the canonical

coordinates and momenta. The result found is $g_{mn}(\tau) = \Phi_{mn}(\tau)/kT$, ($\tau \geq 0$), where $\epsilon g_{mn}(\tau)$ is the average increment in x_m at time t resulting from an infinitesimal increment ϵ externally induced in x_n at time $t - \tau$, $\Phi_{mn}(\tau)$ is the covariance $\langle x_m(t)(\partial E / \partial x_n)^t \rangle$, where the prime denotes argument $t - \tau$, k and T are Boltzmann's constant and absolute temperature. This relation is derived as a direct consequence of the fact that two initially isolated systems in equilibrium at identical temperatures remain in equilibrium when weakly coupled to each other.

530.162 : 539.12

SPHERICAL HARMONICS METHOD IN NEUTRON TRANSPORT THEORY. See Abstr. 4916.

530.19 : 535.43 : 538.566.2

5388. THEORETICAL STUDY OF THE PENETRATION OF RADIATION IN NATURAL SCATTERING MEDIA. J.Lenoble.
Optica Acta, Vol. 4, No. 1, 1-11 (March, 1957). In French.

The equation governing the penetration is given and Chandrasekhar's approximate method of resolution is summarized. This method is applied to a layer of haze and to the sea; the approximations are discussed.

GENERAL MECHANICS MECHANICS OF SOLIDS

531.39

5389. THE SPACES IN A UNIFORM RANDOM SUSPENSION OF FIBRES. A.G.Ogston.

Trans Faraday Soc., Vol. 54, Pt 11, 1754-7 (Nov., 1958).

The distribution of spaces in a random network of straight fibres is considered, such as might be occupied by a spherical object placed within the network or might allow free rotation to an elongated one. The approximate treatment of a network of flexible fibres is discussed briefly.

531.45

5390. THEORY OF A CYLINDER ROLLING ON A SURFACE COVERED WITH A LAYER OF PLASTIC LUBRICANT.

L.I.Kotova and B.V.Deryagin.

Zh. tekhn. Fiz., Vol. 27, No. 6, 1261-71 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 6, 1154-64 (June, 1957).

Expressions are obtained for the pressure distribution in a lubricant layer, the load-bearing capacity of the layer and the power consumed in overcoming friction in the layer for the case of constant limit shear stress. An expression is obtained for the pressure distribution in a lubricant layer for the case where the shear stress depends exponentially upon pressure. It is found that in this case, there is a limiting minimum thickness of lubricant layer in the gap between cylinder and rolling surface.

531.539 : 525.3

ON THE BEHAVIOUR, ACCORDING TO NEWTONIAN THEORY, OF A PLUMB LINE OR PENDULUM ATTACHED TO AN ARTIFICIAL SATELLITE. See Abstr. 5339

MECHANICAL MEASUREMENTS

531.715 : 535.421

PRECISION MEASUREMENT OF THE GRATING CONSTANT OF A CONCAVE GRATING. See Abstr. 4489

531.76 : 529.786 : 621.317.36

5391. CAESIUM BEAM STANDARD OF FREQUENCY.

S.N.Kalra, R.Bailey and H.Daams.

Canad. J. Phys., Vol. 36, No. 10, 1442-3 (Oct., 1958).

A caesium molecular beam apparatus, using the Ramsey technique of separated microwave fields, is used to control a quartz oscillator. An accuracy of better than 1 in 10^9 is obtained.

D.Walsh

531.76 : 529.786 : 621.374.32

5392. VERNIER CHRONOTRON. H.W.Lefevre and J.R.Russell. Rev. sci. Instrum., Vol. 30, No. 3, 159-66 (March, 1959).

The instrument described is a multichannel time interval analyser with digital output for use in the millimicrosecond region. The analyser consists of two circulating transmission lines with a single fast coincidence circuit between them and associated gating circuits. Each circulating line is a precisely trimmed coaxial cable with its ends joined by a two-stage noninverting saturating amplifier. A circulating pulse delivers time marks to the input of the coincidence circuit. By making the circulation periods of the two lines slightly different, the time marks are made to arrive at slightly different frequencies. The instrument is a true vernier. To measure an interval it is only necessary to count the number of circulations before coincidence and multiply by the difference in circulation period of the lines. A commercial 256-channel magnetic core memory is used for storage. The circuit of the instrument is described. A method is described for predicting circulation threshold, growth to equilibrium, and equilibrium amplitude of a circulating pulse from the amplifier transfer characteristic. Data are presented which indicate the linearity, stability, and time resolution of the instrument. See also following abstract.

531.76 : 529.786 : 621.374.32

5393. VERNIER CHRONOTRON TIMES NUCLEAR PARTICLE FLIGHT. H.W.Lefevre and J.T.Russell. Electronics, Vol. 32, No. 10, 44-7 (March 6, 1959).

For abstract, see preceding abstract.

MECHANICS OF FLUIDS

532.112 : 539.383

EFFECT OF HYDROSTATIC PRESSURE ON ANELASTIC RELAXATION. See Abstr. 5204

532.13 : 536.2.022

5394. MOLECULAR TRANSPORT PROPERTIES OF FLUIDS. E.F.Johnson. Industr. engng Chem., Vol. 51, No. 3(II), 399-401 (March, 1959).

Review of literature published since October, 1957 on the viscosity and thermal conductivity of homogeneous fluids. Work on non-Newtonian fluids and very dilute solutions is not included. Experimental and theoretical investigations are considered. 66 references.

532.133

5395. TEMPERATURE-PRESSURE-STRUCTURE EFFECTS ON THE VISCOSITY OF SEVERAL HIGHER HYDROCARBONS. D.A.Lowitz, J.W.Spencer, W.Webb and R.W.Schiessler. J. chem. Phys., Vol. 30, No. 1, 73-83 (Jan., 1959).

The viscosity of fourteen very pure high molecular weight hydrocarbon liquids was determined at six temperatures, ranging from 37.78° C to 135° C, and at pressures ranging from atmospheric to 3400 bars, by use of a rolling-ball viscometer. For nine of the liquids whose PVT data were not available, a flexible bellows piezometer was used to determine the density between the same limits of temperature and pressure as employed for the viscosity measurements. The hydrocarbons selected vary in molecular weight from 268.5 to 535.0 and comprise several structural symmetry families involving progressive cyclization to cyclohexyl, phenyl, and decalyl groups. Also included are an alkyl-naphthalene, an alkyl-decahydro-naphthalene, two hydrochrysenes, an homologous series of branched paraffins, and a series of 1, 1-diphenylalkanes. Correlations are made of structure with viscosity, rate of change of viscosity with pressure, and enthalpy of activation for viscous flow. The effects of molecular weight and of molecular structure on viscosity are discussed.

532.23

5396. LIQUID/LIQUID EQUILIBRIUM IN A WATER-BENZENE-ACETONE SYSTEM. G.Arigh and G.Tagliavini. Ricerca sci., Vol. 28, No. 8, 1620-7 (Aug., 1958). In Italian.

Liquid/liquid equilibrium for a water-benzene-acetone system at the temperatures of 20°, 40° and 60° C was investigated. The authors report data on miscibility and on the distribution of acetone between water and benzene; the results are compared with those which might be expected from the measurements of the liquid-vapour equilibrium.

5397. FLUID DYNAMICS.

A.K.Oppenheim, C.V.Sternling, C.A.Sleicher, Jr and R.A.Stern. Industr. engng Chem., Vol. 51, No. 3(II), 437-52 (March, 1959).

Review of recent literature (books, periodical articles, conference proceedings and reports) on the following: Equations of motion and stability; Turbulence; Vortex flow and rotation; Jets and wakes; Flow near solid surfaces; Multiphase and free-boundary flow; Gas dynamics; Wave dynamics; Dynamics of reactive fluids; Dynamics of conducting fluids. The bibliography (arranged under the foregoing headings) contains 329 references.

532.517

5398. A FLOW PROBLEM SOLVED BY STRIP METHOD. G.Kärrholm.

Chalmers Tekn. Högsk. Handl., No. 208, 22 pp. (1959).

The slow, steady flow of a viscous fluid perpendicular to parallel, regularly-spaced, infinite cylinders is studied by a difference method. This method implies the substitution of derivatives with respect to one of two independent variables by finite differences. The flow problem is treated with reference to an analogous problem in the theory of elastic plates. The approximate solution is compared with experimental results obtained by other workers.

532.517.2 : 536.22

HEAT TRANSFER IN NON-NEWTONIAN LAMINAR FLOW IN TUBES. See Abstr. 4514

532.525

5399. OBLIQUE IMPACT OF A BOUNDED STREAM ON A PLANE LAMINA. T.Sarpkaya. J. Franklin Inst., Vol. 267, No. 3, 229-42 (March, 1959).

Helmholtz's free streamline theory is used to determine the contraction coefficients of two jets formed by a finite, two-dimensional stream impinging obliquely upon a plane lamina placed between two infinite parallel planes. The agreement between the results obtained from experiments and those calculated from theory is excellent. The theory is expected to be useful as a design tool for such boundary configurations as those represented by butterfly valves.

532.57 : 621.317.79

5400. AN EQUIPMENT FOR THE MEASUREMENT OF LOW VELOCITIES OF LIQUIDS. J.Vepfek.

Slaboproudý Obzor, Vol. 19, No. 8, 528-34 (1958). In Czech.

The device described can be used for direct (or recorded) measurements of the velocity of liquids in the range 3-100 cm/s or 5-100 cm/s, and consists of a transducer and an electronic metering circuit. The transducer consists of a five-blade microturbine and a specially shaped gold-plated cross which is driven by the turbine. The cross revolves between two cylindrical platinum electrodes, so that it produces a nearly sinusoidal change of the inter-electrode resistance. The transducer (the two electrodes) is supplied with an a.c. signal having a frequency of 11 kc/s and is connected in a bridge circuit. Rotation of the cross produces amplitude modulation of the bridge output voltage. The resulting signal is amplified and then applied to a detector, where the modulating waveform is recovered. The signal from the detector is converted into short, frequency-independent pulses. The average repetition rate of the pulses, which is proportional to the velocity of the turbine, is read directly on a galvanometer. The operation of the transducer is analysed in detail and circuit diagrams of the electronic equipment are given.

R.S.Sidorowicz.

532.570.8

5401. THE TOTAL-COUNT TECHNIQUE: A NEW PRINCIPLE IN FLOW MEASUREMENT. D.E.Hull.

Internat. J. appl. Radiation and Isotopes, Vol. 4, No. 1-2, 1-15 (Dec., 1958).

Describes a new principle for measuring flow in all kinds of streams. A known quantity of radiotracer A is mixed in the flowing stream. A counter fixed in or near the stream, some distance downstream, registers a total of N counts from the tracer while it passes. The flow rate Q is given by the relation $Q = AF/N$, where the constant factor F is determined by laboratory calibration of the counter. This simple formula is a completely general expression for the absolute flow rate of liquids and gases in any kind and size of conduit. It applies without modification over an extremely wide range. The total count above and below the junction of confluent streams measures the flow at each point. The total count in a divergent stream, no matter what fraction of the traced stream it carried, depends only on the flow of the whole stream. These principles are applied

to measure flow of water and oil in pipes in operating industrial plants. Also, water flow is measured in open channels and natural streams. Other applications of the total-count method are to the measurement of leaks in condensers and heat exchangers, and of entrainment in distillation columns.

532.582.3

5402. ON THE MOTION OF TWO CYLINDERS IN AN IDEAL FLUID. L.H.Carpenter.

J. Res. Nat. Bur. Stand., Vol. 61, No. 2, 83-7 (Aug., 1958).

The complex potential of two cylinders moving in an infinite liquid is determined by the method of image doublets, and the solution is expressed as an infinite series in rectangular coordinates. Approximate solutions in finite form are given for various cases. A method for generalizing the solution for the case of more than two cylinders is indicated. Applications to the flow induced by a cylinder moving in the presence of plane boundaries are given and the stream lines are illustrated in certain cases.

532.6

5403. SOME INTERFACIAL PHENOMENA AMONG LIQUID SULFUR, WATER, SOLID AND GAS. T.Matsushima and K.Ono. Sci. Rep. Res. Insts Tohoku Univ. A, Vol. 10, No. 5, 375-87 (Oct., 1958).

Some interfacial phenomena between liquid sulphur, solid and gas, between liquid sulphur, water and gas and between liquid sulphur, water and solid were quantitatively determined, and the mechanism of the extraction of sulphur from its ore in an auto-claving method is illustrated. (1) In the system of liquid sulphur, solid and gas connected by the adhesional work of liquid on solid, the contact angle of liquid sulphur was determined with fused silica and pyrite. The contact angle of liquid sulphur on fused silica and pyrite were 60.0° and 58.4° between 120 and 160°C . Due to the effect of the vaporization of liquid sulphur, it did not give true contact angle above 160°C . (2) The system of liquid sulphur, water and gas was studied by the formation of liquid lens of the supercooled liquid sulphur on the surface of water at 40°C . As a result, the interfacial tension between liquid sulphur and water was compared with the previous work. (3) In the system of liquid sulphur, water and solid, the interfacial contact angle between liquid sulphur and water on fused silica was measured at 120°C . The result by the drop method was 130.3° from liquid sulphur to water. This result showed that the difference of the adhesional work of liquid sulphur and that of water on fused silica was -31.0 dyne/cm at 120°C .

532.612.4

5404. SURFACE TENSION OF DILUTE AQUEOUS SOLUTIONS OF ELECTROLYTES. U.Tarnick.

Exper. Tech. der Phys., Vol. 5, No. 4, 162-72 (1957). In German.

A comparison of published experimental data on the concentration dependence of the surface tension of aqueous solutions of electrolytes indicates that the methods of determination are not yet free from error. In consequence, the relative increase of surface tension for aqueous solutions of NaCl, NaBr, and KBr over that of pure water has been measured by a drop-pressure precision method based on Long and Nutting's apparatus (Abstr. 1026/1943) which has been modified for the removal of defects and simplification of procedure. The resulting data do not show a minimum in the course of the surface tension-concentration curve as found by Jones and Ray (Abstr. 1250/1942) for any of the salts investigated. The problem is thus raised as to the validity of the Onsager-Samaras theory (Abstr. 4067/1934) for small concentrations. There are four diagrams and 15 references.

H.H.Hodgson

532.63

5405. THEORETICAL ANALYSIS OF RATE OF LIQUID ABSORPTION BY CAPILLARY ABSORBING MEDIA. A.R.W'inch. Textile res. J., Vol. 29, No. 3, 193-9 (March, 1959).

Emphasizes the critical importance of environmental factors to the rate of liquid absorption (as well as factors which are specific to the structure of the absorbent mass). The theoretical relationships of environmental factors and capillary structure are combined in an over-all rate of flow equation. From this equation many theoretical conclusions of interest may be drawn. The equation also suggests principles for design of capillary structures for optimum rate of absorption in proper relationship to external or competing environmental factors.

532.68

5406. THE PENETRATION OF MERCURY AND CAPILLARY CONDENSATION IN PACKED SPHERES. S.Kruyer.

Trans Faraday Soc., Vol. 54, Pt 11, 1758-67 (Nov., 1958).

The theory of mercury penetration and retraction in packings of uniform spheres was developed. Hysteresis is predicted. The penetration branch is equivalent to the desorption branch in capillary condensation. The retraction branch is equivalent to the adsorption branch in capillary condensation. The penetration and retraction in packings of three samples of glass spheres with diameters between 1 and 0.2 mm and of stainless steel balls ($d = 0.794 \pm 0.002$ mm) was measured. The experimental results are in agreement with theory.

532.696.1

5407. INVESTIGATION OF THE WETTABILITY OF CERTAIN MATERIALS BY MOLTEN GLASS. M.G.Chernyak and G.G.Naidus. Zh. tekhn. Fiz., Vol. 27, No. 10, 2268-72 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 10, 2108-11 (Oct., 1957).

Study of the wettability of platinum, its alloys, and some other materials by molten glass at temperatures used in glass fibre formation. An improved technique for wettability determinations under these conditions is described. The results of the experiments confirmed the existence of a relationship between the wettability of platinum and its alloys by molten glass, and the oxidizability of the metals.

MOLECULAR THEORY OF LIQUIDS

532.7

5408. MASS TRANSFER.

C.R.Wilke, J.M.Prausnitz and A.Acrivos.

Industr. engng Chem., Vol. 51, No. 3(II), 466-71 (March, 1959).

Review of recent literature (book, periodical articles, conference proceedings, reports) on the following: Molecular diffusion and separation processes; Turbulent diffusion and mixing processes; Mass transfer by diffusion and convection; Interfacial phenomena. The bibliography (arranged under the foregoing headings) contains 84 references.

532.7 : 536.48

CONTRIBUTION TO THE PHONON THEORY OF FLUIDS.

See Abstr. 4526

532.7 : 536.48

THEORY OF A FERMI LIQUID (THE PROPERTIES OF LIQUID He^3 AT LOW TEMPERATURES). See Abstr. 4527

532.712

5409. DESIGN AND PERFORMANCE OF A BLOCK-TYPE OSMOMETER. D.McIntyre, G.C.Doderer and J.H.O'Mara.

J. Res. Nat. Bur. Stand., Vol. 62, No. 2, 63-6 (Feb., 1959).

Several new features are utilized which enhance the precision of the osmotic-pressure measurement and allow simpler manipulative techniques. The details of the construction, as well as a discussion of the design and performance, are included.

532.72

5410. ON THE INFLUENCE OF CONVECTION ON DIFFUSION. V.B.Fiks.

Zh. tekhn. Fiz., Vol. 27, No. 6, 1282-8 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 6, 1176-83 (June, 1957).

It is shown that, for the diffusion in a liquid moving in a long tube, the effect of the convection currents in the liquid on the transport of a dissolved substance reduces under specified conditions to a diffusive mixing along the axis of the flow. The variation of concentration of the dissolved substance is described by a differential equation of convective diffusion, in which the coefficient of convective diffusion has the usual physical meaning. The limits are indicated within which the equation of convective diffusion is valid.

5411. ON THE X-RAY DIFFRACTION IN WATER-DIOXANE AND WATER-ETHYL ALCOHOL MIXTURES. F.Cennamo and E.Tartaglione. *Nuovo Cimento*, Vol. 11, No. 3, 401-9 (Feb. 1, 1959).
From the behaviour to X-ray diffraction, it is shown that the molecular association of water is attenuated by dioxane, whereas it is favoured by ethyl alcohol.

5412. CLOSEST ATOM PACKING AND LAYER-PACKET FORMATION IN MONATOMIC MOLTEN METALS. H.Richter, G. Breitling and F.Herre. *Z. Naturforsch.*, Vol. 12a, No. 11, 896-925 (1957). In German.
The distribution of intensity in X-rays scattered from monatomic molten metals shows that the positions of the maxima are determined essentially by the shortest distance between the atoms. It is found that there is a closest packing of the atoms in accordance with the statistical sphere model. Further investigation shows that, particularly near the melting point, there is superposed a packet structure. With increasing temperature this becomes less evident and disappears.

5413. KNIGHT SHIFT IN SODIUM-AMMONIA SOLUTIONS. W.E.Blumberg and T.P.Das. *J. chem. Phys.*, Vol. 30, No. 1, 251-6 (Jan., 1959).
Two wave-functions were obtained for the electrons in sodium-ammonia solutions by a numerical procedure from two potential wells based on the model proposed by Becker, Lindquist and Alder for metal-ammonia solutions. These wave-functions were used to calculate the expected Knight shift in the region < 0.5 molar by means of an n -electron formalism previously found successful in treating the hyperfine interaction of F-centres. The results have been compared with the experimental values of McConnell and Holm for the Knight shifts of Na and N in sodium-ammonia solutions, and agree quite favourably. In particular, these calculations show that the N resonance shift will decrease with dilution, while the Na shift will increase with dilution, between 0.5 and 0.03 molar. The H shift is shown to be less than 10^{-8} for all concentrations < 0.5 molar, giving an explanation of why it was not experimentally observed. Dependence of the Knight shift upon concentration is predicted for the range < 0.05 molar, which has not yet been investigated experimentally.

5414. SOLUTIONS UNDER PRESSURE. J.S.Rosen. *J. chem. Phys.*, Vol. 30, No. 2, 547-55 (Feb., 1959).
A method is given which permits the calculation of the volumes of aqueous solutions of salts at higher pressures solely from the volumes of these solutions at atmospheric pressure and the compressibility data of the pure substances involved. The volumes of aqueous solutions of sodium chloride, ammonium nitrate, and potassium sulphate are computed to 10 000 bars pressure and these agree with the observed values to within a fraction of 1%. Tammann's hypothesis, to the effect that water in solution is compressed by an ionized solute, is used, but the extension of this hypothesis permits the calculation of the volumes of the solute and the water in solution and the effect of pressure on these volumes. The interpolation formulae derived also appear to be applicable to nonaqueous solutions of salts; some tentative results are also given for mixtures of liquids (ethyl alcohol in water). An equation is introduced which, like Tait's equation, represents the variation of volumes with pressure. This equation is fundamental to the development of the interpolation equations for solutions which are given in this paper. It is found that an analogous equation reproduces refractive index and dielectric constant data for liquids and gases at high pressures. This leads to an equation, previously proposed, which is considered more useful in representing experimental data analytically than the corresponding formulae of Lorenz-Lorentz and Mossotti-Clausius.

5415. INVESTIGATIONS ON ION-SOLVENT INTERACTION, PARTICULARLY ON THE BASIS OF VISCOSITY MEASUREMENTS. M.Kaminsky. *Z. Naturforsch.*, Vol. 12a, No. 5, 424-33 (1957). In German.
The theory of very dilute (10^{-3} mole/l) aqueous solutions of strong electrolytes has been based upon the interaction forces between the ions. At higher concentrations (up to 10^{-1} mole/l) interaction forces between the ions and the solvent molecules

become important. The temperature coefficient of the corresponding interaction coefficient can be either negative or positive, as with those of molar heat and molar volume. Two rules have been evolved from viscosity measurements: (1) within a particular group of the periodic table (alkalis, alkaline earths, halogens) the values of the coefficient of ion-solvent interaction decrease with increasing ion radius (as determined from the crystal lattice); (2) within a particular group of the periodic table the temperature coefficient of the coefficient of ion-solvent interaction tends to change from negative or slightly positive values to larger positive values as the radius of the ions considered becomes larger. This again is the ion radius as determined from the crystal lattice.

5416. TRANSITION POINT [KLÄRPUNKT] AND ANISOTROPY OF MOLECULAR POLARIZABILITY IN LIQUID-CRYSTALLINE SUBSTANCES. W.Maier and A.Saupe. *Z. Naturforsch.*, Vol. 12a, No. 8, 668-9 (1957). In German.
A consideration of the influence of molecular structure on the formation of liquid crystals.

MECHANICS OF GASES VACUUM TECHNIQUE

5417. THE THEORY OF THE SWING SEPARATOR. B.L.van der Waerden. *Z. Naturforsch.*, Vol. 12a, No. 7, 583-98 (July, 1957). In German.
The swing separator (Abstr. 6800/1955) is a device for accurately measuring the thermal diffusion constant α for such small temperature differences that a "true" rather than an average value is obtained. In this paper the theory of the method is fully described and systematic errors are estimated.
5418. SOME EXPERIMENTS ON THE DIFFUSION OF Xe^{133} FROM URANIUM OXIDES. R.Lindner and H.J.Matzke. *Z. Naturforsch.*, Vol. 13a, No. 9, 794-6 (Sept., 1958). In German.
The possibility of measuring the diffusion of Xe^{133} from crystalline uranium oxides has been shown. UO_2 of purity < 0.1 p.p.m. B and < 100 p.p.m. Na and Ca has been recrystallized at 1000°C in an atmosphere of A and has then been bombarded with neutrons (6×10^{16} to 10^{17} neutrons/cm²). After allowing for the decay of the short-lived Xe isotopes the specific Xe^{133} activity has been measured as a function of temperature, and the diffusion constants have been calculated from these results. They are appreciably higher for U_3O_8 than for UO_2 . This is particularly the case for sintered samples. With access of air at 1100°C the diffusion constant is larger by a factor of about 1000.

THERMAL DIFFUSION IN GASEOUS NEBULAE. See Abstr. 5322.

5419. HIGH-TEMPERATURE GAS VISCOSITIES. II. NITROGEN, NITRIC OXIDE, BORON TRIFLUORIDE, SILICON TETRAFLUORIDE, AND SULFUR HEXAFLUORIDE. C.P.Ellis and C.J.G.Raw. *J. chem. Phys.*, Vol. 30, No. 2, 574-6 (Feb., 1959).
For Pt I, see Abstr. 6715 (1958). The viscosities of nitrogen (from 700 to 1000°), nitric oxide (from 100 to 1000°), boron trifluoride (from 180 to 500°), silicon tetrafluoride (from 200 to 330°C), and sulphur hexafluoride (from 200 to 850°C) were measured using a specially constructed silica apparatus described in Part I of this series. In addition, previous results for SiF_4 were recalculated in the low-temperature range down to room temperature. These results are discussed from the point of view of the intermolecular forces, and the molecular interaction parameters are compared with those calculated from data on gas viscosities in the lower temperature ranges. The results show the temperatures at which thermal dissociation of the compounds becomes important, and the viscosity measurements are not carried very far beyond these temperatures.

5420. INVESTIGATIONS ON THE VARIATION OF VISCOSITY IN MAGNETIC FIELDS. V. Mercea and I. Ursu. Rev. de Physique (Bucarest), Vol. 2, No. 2, 217-28 (1957). In German.

Describes the apparatus used and the results obtained in an investigation of the variation with magnetic field of the viscosity of oxygen and air. The results are discussed in relation to the theory of gas flow. A.E. De Barr

5421. THE PARAMAGNETIC EFFECT IN THE VISCOUS STREAMING OF OXYGEN-GAS MIXTURES IN A MAGNETIC FIELD, AND ITS USE IN THE INVESTIGATION OF GASES. I. Ursu. Rev. de Physique (Bucarest), Vol. 3, No. 1, 51-5 (1958). In German.

The changes in viscosity of oxygen-hydrogen and oxygen-methane mixtures in a magnetic field have been measured for flow through a fine capillary, and sintered glass. The viscosity changes approach a constant value at a field of about 4000 Oe. The application of the effect to gas analysis is suggested. A.J. Manuel

5422. ROTATING DISK VISCOMETER. V. Mercha, Zh. Mercha and I. Ursu. Rev. de Physique (Bucarest), Vol. 3, No. 1, 45-50 (1958). In Russian.

An apparatus is described in detail which is used for a continuous test of the composition of gas mixtures. It consists of two coaxial parallel disks, one of which is rotating at uniform speed; the other is subject to a restoring force (couple) from a helical spring, which tends to hold it in an equilibrium position. The deflection of the second disk is calibrated to show the viscosity of gases; calibration is based on the viscosity of mixtures of methane with hydrogen and with other gases. R. Eisenschitz

5423. THE PRODUCTION AND MEASUREMENT OF ULTRA-HIGH VACUA. A. Venema and M. Bandringa. Philips tech. Rev., Vol. 20, No. 6, 145-57 (1958-59).

Ultra-high vacua ($< 10^{-7}$ mm Hg) have previously been obtained in shut-off enclosures with an ionization gauge used as a pump. Vacua better than 10^{-12} mm Hg have now been attained with a mercury-diffusion pump. The limiting pressure of such a pump is sufficiently low if the backing pressure is lower than 10^{-6} mm Hg, i.e. when a second diffusion pump is used as backing pump. The pumping speed of such an arrangement is high. In the pumping system described in this article, three traps with extremely low flow resistance ensure that no mercury enters the vessel. The wall area of the vessel, ionization gauge, traps and diffusion pump is as small as practicable; all can be outgassed in a furnace (at 450°C). The collector of the ionization gauge is a wire only 25μ thick mounted inside the other electrodes. In this way the contribution from the X-ray effect corresponds to only 5×10^{-11} mm Hg. Anode and collector are outgassed by electron bombardment (approx. 1200°C).

5424. SOME ASPECTS OF THREE-DIMENSIONAL DIABATIC FLOWS. H.A. Hassan. Proc. Iraqi Sci. Soc., Vol. 2, 11-14 (1958).

Concerned with the way in which the addition (or removal) of heat influences the flow parameters along streamlines, their principal normals and their binormals. Variations of pressure, temperature, density and vorticity are expressed in terms of the geometrical parameters of streamlines and in terms of the quantities representing the heat addition. It is found that the pressure components along the binormals are not affected and remain constant. However, density and temperature variations along the binormals are due only to heat addition.

5425. CURVED SHOCK WAVES IN THREE-DIMENSIONAL GAS FLOWS. See Abstr. 4386

5425. THE SOLUTION OF TRICOMI'S EQUATION FOR A TRANSONIC JET. Pien Yen-kwei. Scientia Sinica, Vol. 7, No. 9, 946-63 (Sept., 1958).

The boundary value problem of a transonic jet formulated in the hodograph plane is to solve the Tricomi equation, $u_{xx} - u_{yy} = 0$, in both subsonic (elliptic) and supersonic (hyperbolic) regions. This

problem is reduced to an inversion of a singular integral equation of the Cauchy type. The inversion is carried out by using Carleman's method which is to transform the singular integral equation into a Hilbert-Riemann problem.

5426. EFFECT OF JET STRUCTURE ON NOISE GENERATION BY SUPERSONIC NOZZLES. See Abstr. 4409

MOLECULAR THEORY OF GASES

5426. NOTE ON THE CORRELATIONS IN A COMPRESSED GAS. P.G. de Gennes. Nuovo Cimento Suppl., Vol. 9, No. 1, 240-2 (1958). In French.

The author has evaluated an expression of the type $\int (g(r)-1)r^4 dr$ (where $g(r)$ is the radial distribution function) by making an Ursell expansion of the integrand as a power series in the density. He uses a Lennard-Jones potential for argon and finds that (a) even near the critical point the integral is positive and (b) the second term in the expansion is only about 2% of the first term. The integral (which appears in addition to the compressibility in the expression for small angle X-ray scattering has been checked against experimental data near the critical temperature. R.O. Davies

5427. CALCULATION OF THE ENERGIES OF GASEOUS ALKALI HALIDE DIMER MOLECULES. See Abstr. 5122

5427. THE KINETIC EQUATIONS OF GAS DISSOCIATION INCLUDING DIFFUSION. A.I. Gubanov and Yu.P. Lun'kin. Zh. tekhn. Fiz., Vol. 27, No. 11, 2631-9 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 11, 2443-50 (Nov., 1957).

A set of equations is obtained which describes the behaviour of a gas in non-equilibrium diffusion and dissociation. A diatomic gas and air (as a five-component mixture) are considered. The temperature dependence of the kinetic coefficients of the equations obtained is investigated.

VIBRATIONS . ACOUSTICS

5428. FORCED OSCILLATIONS IN AN ELASTIC-PLASTIC SYSTEM. See Abstr. 5200

5428. *VIBRATIONS OF A CYLINDRICAL SHELL IN WATER AND ITS EMISSION OF SOUND OF COMPLEX SPECTRAL COMPOSITION. Z.V. Kolotikhina. Akust. Zh., Vol. 4, No. 4, 333-40 (1958). In Russian.

The paper deals with axi-symmetrical vibrations of an infinitely long thin cylindrical shell in an ideal compressible liquid. A transcendental equation is obtained for the natural frequencies of vibrations of the shell. Formulae are derived for the acoustic pressure and vibrational velocity of particles of the medium for frequencies which are multiples of the forced vibrations of the shell.

5429. MECHANICAL RESONANCE DISPERSION IN QUARTZ AT AUDIO-FREQUENCIES. E.R. Fitzgerald. Phys. Rev., Vol. 112, No. 3, 765-84 (Nov. 1, 1958).

Measurements of the complex shear compliance ($J^* = J' - iJ''$) of single crystals of quartz and fused quartz at frequencies from 100 to 5000 c/s have resulted in the discovery of sharp resonances in the compliance similar to those recently found in polycrystalline metals and crystalline polymers. The number, locations, and magnitudes of the resonances depend on crystal orientation with respect to the applied dynamic stress and vary with temperature, external static stress, and, in some cases, with time. The presence of numerous resonances in fused quartz may result from the existence of regions of long-range order (100 to 200 Å) in this material. Analysis of the data on the basis of a generalized stress-strain

relation involving a linear combination of strain and its first and second time derivatives gives a close fit to the experimental curves. An explanation of the resonances is suggested by calculations of Fermi, Pasta, and Ulam for nonlinear systems in which no tendency toward equipartition of energy among modes was found. Accordingly it is proposed that (1) crystalline solids with nonlinear forces between atoms do not share their vibrational energy among all of the available modes, but pass energy back and forth among relatively few modes; (2) the frequency of the energy exchange among modes may be low, and in particular, much lower than the frequencies of the lattice vibrations; and (3) the resonance dispersions observed in the dynamic mechanical compliance of quartz and other materials occur at these various acoustic exchange frequencies. This lack of energy equipartition will not necessarily be noticed in specific heat measurements of solids, but can be expected to have some consequences in other areas.

534.2

5430. BASIC PROBLEMS OF CONTEMPORARY MOLECULAR ACOUSTICS. A REVIEW.

I.G.Mikhailov, V.A.Solov'ev and Yu.P.Syrnikov.
Akust. Zh., Vol. 4, No. 3, 211-22 (1958). In Russian. English translation in: Soviet Physics — Acoustics (New York), Vol. 4, No. 3, 215-26 (July-Sept., 1958).

534.2

5431. ATTENUATION OF RAYLEIGH WAVES ON PROPAGATION ALONG AN UNEVEN SURFACE. L.M.Brekhovskikh.

Dokl. Akad. Nauk SSSR, Vol. 124, No. 5, 1018-21 (1959). In Russian.
Discusses the attenuation of Rayleigh waves due to scattering on the irregularities of a surface along which the waves are propagated. It is assumed that the irregularities are small compared with the Rayleigh wavelength, and that their slopes are gentle. The attenuation coefficient is calculated in general form, and the results are applied to propagation in earth's core, aluminium and steel.

A.Tybulewicz

534.2 : 536.4

5432. THERMOELASTIC WAVES AND THERMAL SHOCK. M.Lessen.

J. Mech. Phys. Solids, Vol. 7, No. 2, 77-84 (March, 1959).
The field equations governing the small displacements of a thermoelastic solid are derived and the properties of plane thermoelastic waves are investigated. Thermal shock solutions are developed using the thermoelastic wave solutions. In addition, the problem of thermal shock in an infinite cylinder is investigated.

534.2

5433. ORIENTATION DEPENDENCE OF ELASTIC WAVES IN SINGLE CRYSTALS. P.C.Waterman.

Phys. Rev., Vol. 113, No. 5, 1240-53 (March 1, 1959).
The perturbed eigenvalue problem that arises when nearly pure transverse or compressional modes are propagated is considered, and the resulting phase velocities and displacement vectors tabulated for a number of cases of physical interest. A unified approach to the properties of pure modes is provided through a consideration of individual rotational symmetries of the crystals, and the energy flux associated with both pure and nearly pure modes is discussed.

534.21

5434. ACOUSTICS OF A MOVING MEDIUM. A REVIEW. L.A.Chernov.

Akust. Zh., Vol. 4, No. 4, 299-306 (1958). In Russian.
This review is selective and reflects the personal interests of the author. The topics dealt with are: propagation of sound in the presence of winds; the principle of reciprocity and the ikonal equation; the ray and wave treatments of the non-uniform moving media (including Blokhintsev's work); scattering of sound and of shock waves; generation and propagation of sound in turbulent media; moving sound sources; sound generation by plates, ellipsoids and cylinders; infrasound (6-13 c/s.) discovered in seas; sound sources in moving media and their protection from winds.

A.Tybulewicz

534.21

5435. PROPAGATION OF SOUND IN "VAN DER WAALS" GASES AND LIQUIDS". A.A.Kaspar'yants.

Akust. Zh., Vol. 4, No. 4, 325-32 (1958). In Russian.
It is assumed that the medium in which sound waves are propagated obeys van der Waals' equation of state. Navier-Stokes' linear equations are applied to such a medium. The velocity of

sound and the absorption coefficient are derived in a form convenient for further calculations. The differential equations of acoustic wave propagation may be used to find the spatial distribution of the acoustic field, allowing for the viscosity and thermal conductivity of the medium.

A.Tybulewicz

534.213.4 : 533.6.011.3

5436. AXIALLY-SYMMETRICAL ACOUSTIC STREAMING AT THE WALLS OF A CYLINDER. P.N.Kubanskii.

Zh. tekhn. Fiz., Vol. 27, No. 6, 1272-5 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 6, 1165-8 (June, 1957).

The theoretical analyses of axially-symmetrical acoustic streaming inside a Kundt tube are extended to apply to the case of streaming which is observed on the outside of the walls of a cylinder. New boundary conditions are formulated, in accordance with which the solutions presented are derived. An expression is obtained for the stream function and streamlines are plotted for a concrete example. The streamlines obtained are in good agreement with a photograph of acoustic streaming (obtained by the shadow method) if the distortion due to natural convection is neglected.

534.22

5437. VELOCITY OF PROPAGATION OF ULTRASOUND IN WATER NEAR ITS FREEZING POINT. N.F.Otpushchennikov.

Akust. Zh., Vol. 4, No. 4, 367-9 (1958). In Russian.
Using a pulse generator, the author found, at 0.5 Mc/s, a minimum of the ultrasonic velocity at +0.7°C and a maximum of the adiabatic compressibility at +2°C. Between +0.7°C and 0°C the ultrasonic velocity was found to rise very steeply, probably because of "precrystallization" changes in water.

534.22

5438. VELOCITY OF SOUND AT DIFFERENT TEMPERATURES IN H₂, N₂, AIR, O₂ AND CO₂. V.Hovi.

Ann. Acad. Sci. Fennicae A VI, No. 18, 18 pp. (1959).
An apparatus for accurate measurements of the velocity of sound in real gases has been constructed. This apparatus was calibrated by using as a standard gas dried air under known conditions. It was found that the agreement between the earlier standard values and the present data was very good. An accuracy of about 0.1% was achieved. The velocity of sound in H₂, N₂, air, O₂, and CO₂ was measured at different temperatures between +19°C and -69°C and at frequencies between 1000 and 3000 c/s. The agreement between the values obtained and those previously measured by means of modern electronic methods was quantitative. Almost in all cases a slight increase in the velocity of sound with increasing frequency was found. This frequency dispersion was considerably smaller than at higher frequencies. The values determined offer a supplement to the earlier data. The possible use of the new data for the empirical determination of the second virial coefficient, B, was suggested.

534.22 : 539.37

5439. EFFECT OF STATICALLY APPLIED STRESSES ON THE VELOCITY OF PROPAGATION OF ULTRASONIC WAVES. R.H.Bergman and R.A.Shahbender.

J. appl. Phys., Vol. 29, No. 12, 1736-8 (Dec., 1958).
Gives the results of an experimental investigation of the changes in the velocities of ultrasonic waves propagating transverse to the direction of applied stress in an aluminium column. The ultrasonic modes considered are longitudinal waves, shear waves with particle motion along the direction of applied stress, and shear waves with particle motion transverse to the direction of applied stress. The experimental results indicate that the relevant elastic constant for longitudinal waves is independent of stress, while that for the shear waves is stress dependent and also depends on the relative orientation of the particle motion and the direction of applied stress.

534.22 : 536.48

5440. VELOCITY OF SOUND IN LIQUID He³. K.R.Atkins and H.Flicker.

Phys. Rev., Vol. 113, No. 4, 959-61 (Feb. 15, 1959).
The velocity of sound in liquid He³ along the vapour pressure curve between 1.2°K and 3.2°K was measured using a pulse technique at 14 Mc/s. Between 2°K and 2.6°K the variation with pressure up to 1 atm was investigated. The results are combined with other known data to calculate various thermodynamic quantities for the liquid. Available data on the specific heat along the vapour pressure curve

were converted into the more theoretically interesting case of the specific heat at constant volume along an isopycnal. The phonon contribution to the specific heat is discussed.

534.22 : 541.124

5441. ULTRASONIC VELOCITY AND ABSORPTION COEFFICIENT IN A CHEMICALLY REACTIVE MEDIUM.

S.Parthasarathy and M.Pancholy.

Z. angew. Phys., Vol. 10, No. 4, 193-4 (April, 1958).

These were measured, using the pulse technique, in an equimolecular mixture of acetic acid and ethyl alcohol on four occasions in seven days following preparation of the mixture. It is assumed that the results indicate the actual progress of the reaction.

H.D.Parbrook

534.22

5442. INVESTIGATIONS INTO THE APPLICABILITY OF ACOUSTIC GRATING METHODS TO GASES. E.Hayess and B.Winde.

Z. phys. Chem. (Leipzig), Vol. 206, No. 3-4, 194-209 (Feb., 1957). In German.

Details are given of a precision method for measuring the velocity of sound and the absorption coefficient of gases as a function of gas pressure; data are quoted for N_2 for pressures up to 85 atm and at frequencies in the range of about 1-10 Mc/s. The accuracy of the velocity measurements was about $\pm 0.3\%$, but ways of improving upon this are suggested. The acoustic method compares favourably with the interferometric method and has special advantages at the higher frequencies.

H.J.H.Starks

534.221

5443. THE MEASUREMENT OF SOUND VELOCITY IN LIQUIDS AT A PRESSURE OF UP TO 2500 ATM. BY AN OPTICAL METHOD.

L.F.Vereshchagin and N.A.Yuzefovich.

Zh. eksper. teor. Fiz., Vol. 34, No. 2, 534-6 (1958). In Russian.

English summary: PB 141052T-1, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

The optical lay-out of the apparatus is shown in a diagram. The ultrasonic oscillations were excited by a piezo-quartz plate connected to a high-frequency generator. The range of frequencies covered was from 3-4 Mc/s. The ultrasonic oscillations penetrated through the vessel into the liquid to be investigated. In order to let light pass two glass windows were mounted on the vessel. The experiments were carried out at temperatures from 19° to 20° C. The dependence of the sound velocity c on the pressure p for the three liquids investigated is shown in a diagram. These curves are slightly concave to the pressure axis. With carbon tetrachloride the sound velocity could not be measured at pressures above 1200 atm. excess pressure.

534.222.2 : 536.5

5444. TEMPERATURE AND HEAT CAPACITY OF "PLEKSI GLASS" ($C_6H_8O_2$)_n COMPRESSED BY A SHOCK WAVE.

Ya.B.Zel'dovich, S.B.Kormer, M.V.Sinitsyn and A.I.Kuryapin.

Dokl. Akad. Nauk SSSR, Vol. 122, No. 1, 48-50 (1958). In Russian.

Photochromographic observation of the wave-front of a shock wave, in a transparent substance like $(C_6H_8O_2)_n$, leads to an estimation of temperature from the luminescence of the compressed body. Using shock wave velocity of 16.5 km/sec, the density of "pleksiglass" increased 2.7 times under pressure of 2×10^{12} dynes/cm. The radiation temperature, obtained at $\lambda = 6000$ Å was $8300 \pm 500^\circ$ K while colour temperature over the whole visual spectrum was $11000 \pm 1000^\circ$ K. The calculated heat capacity was 3.5 times greater than that measured at room temperatures.

J.K.Skwarzynski

534.222.2 : 539.89

5445. SHOCK-WAVE COMPRESSION OF ALUMINUM.

D.G.Doran, G.R.Fowles and G.A.Peterson.

Phys. Rev. Letters, Vol. 1, No. 11, 402-4 (Dec. 1, 1958).

Describes a new experimental technique using oblique shocks in which the shock and free-surface velocities are measured by an optical method, providing simultaneous pressure-compression data over a large range including that below 50 kilobars. The pressure-compression curve for Al up to 130 kilobars has been measured, and agrees well with previous dynamic measurements and with Bridgman's static measurements, tending to confirm the usual assumptions used in interpreting shock compression data.

J.Hawgood

534.222.2

5446. CONCERNING THE STABILITY OF SHOCK WAVES.

V.M.Kontorovich.

Zh. eksper. teor. Fiz., Vol. 33, No. 6(12), 1525-6 (1957). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 6(33), No. 6, 1179-80 (June, 1958).

Discusses the conditions for the formation of an undamped travelling wave as a perturbation of a shock wave. The emitted wave may move either in the opposite direction to the shock, as envisaged by D'yakov (Abstr. 3512/1954), or in the same direction as the shock with smaller velocity.

J.Hawgood

534.222.2 : 534.24

5447. REFLECTION AND REFRACTION OF SOUND BY A SHOCK WAVE. V.M.Kontorovich.

Zh. eksper. teor. Fiz., Vol. 33, No. 6 (12), 1527-8 (1957). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 6 (33), No. 6, 1180-1 (June, 1958).

Theoretical note giving general expressions which, for oblique incidence, are more accurate than those given by Brillouin (Abstr. 9505/1955), and, for normal incidence and an ideal gas, reduce to those previously obtained.

H.D.Parbrook

534.222.2 : 537.523.4

5448. X-RAY STUDIES OF THE SHOCK WAVES FROM SPARKS IN GASES. K.H.Herrmann.

Z. angew. Phys., Vol. 10, No. 8, 349-56 (Aug., 1958). In German.

Describes an X-ray pulse technique for studying, by absorption methods, the shock waves emitted in the early stages of spark channel formation. Most attention was paid to argon sparks and detailed results (e.g. on shock wave expansion etc.) are given, but some data are given for air and CO_2 .

J.D.Craggs

534.222.2

5449. THE STRUCTURE OF SHOCK WAVES. Yu.P.Lun'kin.

Zh. tekh. Fiz., Vol. 27, No. 6, 1276-81 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 6, 1169-75 (June, 1957).

A method is proposed for analysing the non-equilibrium processes which occur in a shock wave. The variation of the gas parameters is evaluated while taking into account the excitation of vibrations and the dissociation of molecules.

534.23 : 533.652

5450. THE BEHAVIOUR OF PLANE ULTRASONIC WAVES IN HOMOGENEOUSLY MAGNETIZED SINGLE CRYSTALS. G.Simon.

Z. Naturforsch., Vol. 13a, No. 2, 84-9 (Feb., 1958). In German.

Magnetostriction gives rise to fluctuating magnetic fields, when ultrasonic waves pass through the magnetized crystal. Calculations are given of the interaction of these fields with the elastic waves, leading on the one hand to a dependence of the propagation velocity on the magnetic state of the material, and on the other hand to a dampening of the waves, which increases with the conductivity.

B.T.M.Willis

534.23

5451. ATTENUATION OF HARMONIC WAVES IN MIXTURES.

Ya.Z.Kleiman.

Akust. Zh., Vol. 4, No. 4, 365-7 (1958). In Russian.

The author discusses attenuation of plane harmonic waves in a two-component medium (gas or liquid). The attenuation is taken to be due only to friction caused by the difference in velocities of particles of the two components; viscosities of both components taken singly are neglected.

A.Tybulewicz

534.23

5452. ATTENUATION OF FINITE-AMPLITUDE PLANE ACOUSTIC WAVES IN GASES.

B.F.Podoshevnikov and B.D.Tartakovskii.

Akust. Zh., Vol. 4, No. 4, 369-71 (1958). In Russian.

Attenuation of 13 kc/s acoustic waves in air was studied as a function of the acoustic intensity. An electrodynamic resonance generator was used to excite air in a tube of 125 cm length and 12.4 cm diameter. The radiated wave was not quite planar. The attenuation coefficient was found to increase linearly with rise of the mean acoustic pressure.

A.Tybulewicz

534.23 : 532.771

5453. ULTRASONIC ABSORPTION ASSOCIATED WITH TERTIARY BUTANOL COMPLEX FORMATION IN DILUTE SOLUTIONS IN CYCLOHEXANE. R.S.Musa and M.Eisner.

J. chem. Phys., Vol. 30, No. 1, 227-33 (Jan., 1959).

Ultrasonic absorption measurements were used as a basis for studying the kinetics of the reaction between tertiary butanol monomers and tetramers, occurring in dilute solutions with cyclohexane. Measurements made at 6, 15, and 27°C over a frequency range of 5 to 53 Mc/s reveal several concentration dependent relaxation effects. An analysis using thermodynamically determined degree of dissociation leads to the determination of the equilibrium constant, rate constants and the heat of reaction. The excess absorption up to 0.02 mole fraction butanol concentration is reasonably well accounted for by the perturbation of the tetramer-monomer equilibrium.

534.23

5454. ULTRASONIC RELAXATION IN ROTATIONAL ISOMERS.

J.H.Chen and A.A.Petrauskas.

J. chem. Phys., Vol. 30, No. 1, 304-7 (Jan., 1959).

Ultrasonic absorption peaks were observed in liquid 2,3-dimethylbutane, 2-methylpentane, and in 3-methylpentane in the frequency range 3 to 35 Mc/s. The mechanism of absorption can be explained in terms of hindered rotation about the middle C-C bond in 2,3-dimethylbutane and about the second and third C-C bond in pentanes. The energy differences between potential minima were found to be about 0.95 kcal/mole in all three liquids. The activation energy of 2-methylpentane was found to be about 3.9 kcal/mole.

534.23 : 539.2

5455. ACOUSTICAL ABSORPTION ARISING FROM MOLECULAR RESONANCE IN SOLIDS. L.Liebermann.

Phys. Rev., Vol. 113, No. 4, 1052-5 (Feb. 15, 1959).

Resonance phenomena resulting in anomalously high acoustic absorption can occur whenever lattice and internal molecular vibrational frequencies overlap. Significant effects are predicted at all acoustic frequencies, without restriction to the resonance region. A method is given for calculating resonance absorption using available molecular constants. As an illustrative example, the magnitude of resonance absorption was calculated for benzene. The predicted absorption is 0.5 cm^{-1} at the 10 Mc/s frequency, orders of magnitude larger than have been observed in other single crystals. In order to test this prediction, measurements of absorption were made on a large single crystal of benzene yielding at 10 Mc/s, 0.25 cm^{-1} . This agreement between absorption and calculated values is considered adequate, confirming the phenomenon.

534.23

5456. ULTRASONIC ABSORPTION IN MIXTURES OF ORGANIC LIQUIDS. I. M.Mokhtar and K.Salama.

Proc. Math. Phys. Soc. Egypt, No. 21, 77-82 (May, 1957).

The absorption of ultrasonic waves was measured in mixtures of organic liquids representing the three groups, non-associated non-polar, non-associated polar and associated polar molecules. Benzene and carbon tetrachloride are taken to represent the first group. Chloroform, toluene and nitrobenzene represent the second group. n-propyl alcohol and ethyl alcohol represent the third group. The method used for the ultrasonic absorption measurements is the ordinary balance method.

534.23

5457. EFFECT OF DIPOLE MOMENT AND TEMPERATURE ON THE ULTRASONIC ABSORPTION IN MIXTURES OF ORGANIC LIQUIDS. II. M.Mokhtar and K.Salama.

Proc. Math. Phys. Soc. Egypt, No. 21, 83-91 (May, 1957).

The absorption of ultrasonic waves was measured in nine mixtures of the seven organic liquids: benzene, carbon tetrachloride, toluene, chlorobenzene, nitrobenzene, ethyl alcohol and n-propyl alcohol, which represent different states of association and different degrees of polarity. Ultrasonic absorption peaks have been found in mixtures of ethyl alcohol with carbon tetrachloride, toluene, chlorobenzene and nitrobenzene. Also the same peaks are found when ethyl alcohol is replaced by n-propyl alcohol in the previous mixtures. A comparison between the two series of mixtures shows a shift of the position of the peak towards the lower concentration of the alcohol component, as the dipole moment of the non-associated liquid decreases. By lowering the temperature of the mixtures, the position of the peaks are unaltered but their heights increase. Discussion of these results give further support to the presence of structural relaxation processes in these mixtures.

534.23 : 539.31

5458. RELAXATION PROCESS IN BISMUTH. K.M.Matta.

Proc. Math. Phys. Soc. Egypt, No. 21, 135-46 (May, 1957).

The velocity and the internal friction with flexural waves were measured for six different samples of bismuth at frequencies in the acoustic range and at temperatures varying from room temperature to the melting point. The velocity was found to decrease linearly with temperature while the internal friction curves have shown a peak resulting from a relaxation process in the metal. Possible atomic mechanisms in the crystal structure are reviewed and this relaxation phenomena is believed to have its origin at the grain boundary. The effect of annealing on the metal samples is discussed and the heat of activation of this relaxation process is found to be 25 kcal/mole.

534.23

5459. ATTENUATION OF THE ULTRASONIC WAVES IN METALS.

II. STAINLESS STEEL. T.Hirone and K.Kamigaki.

Sci. Rep. Res. Insts Tohoku Univ., Vol. 10, No. 4, 276-82 (Aug., 1958).

Ultrasonic attenuation coefficients of stainless steel with various grain sizes were measured by a pulse method at frequencies ranging from 0.5 to 6 Mc/s. The stainless steel used was of austenite structure containing about 19% of chromium and 10% of nickel. The attenuation coefficient increased rapidly with frequency, and the increase was more rapid with increasing size of crystal grains. This behaviour was explained by assuming that the travelling ultrasonic waves are scattered by the austenite crystal grains in accordance with Rayleigh's law.

534.23

5460. A RESONANCE METHOD FOR THE MEASUREMENT OF ULTRASONIC ABSORPTION IN FERROMAGNETIC SPECIMENS.

H.J.Goehlich.

Z. Naturforsch., Vol. 13a, No. 2, 90-8 (Feb., 1958). In German.

Describes an experimental arrangement for the measurement of ultrasonic absorption in the region of 10^7 c/s in small discs of ferromagnetic material. The velocity of sound in the materials and the ΔE effect can also be investigated. The theory underlying the measurements is described, and the errors and difficulties are discussed.

A.E.De Barr

534.231

5461. MEASUREMENT OF THE INTERACTION OF SOUND WAVES IN LIQUIDS. V.A.Zverev and A.I.Kalachev.

Akust. Zh., Vol. 4, No. 4, 321-4 (1958). In Russian.

If a high-frequency wave interacts with a low-frequency wave which crosses it at right-angles, then the high-frequency wave is phase modulated. The interaction is due to the non-linearity of the medium which appears primarily as the non-linearity of the equation of state. The phase modulation of the high-frequency wave is due to a periodic change of its velocity in the field of the stronger low-frequency wave. The authors studied interaction of 1.3 Mc/s and 3 kc/s waves in tap water, in 93.5% ethyl alcohol and in a 21.6% NaCl solution, using the apparatus described earlier by Gorelik and Zverev (Abstr. 4906/1956). The results obtained agree with the authors' theoretical calculations.

A.Tybulewicz

534.232

5462. THE DESIGN OF A PISTON PIEZOELECTRIC RADIATOR. NEGLECTING INTERNAL LOSSES. A.A.Anan'eva.

Akust. Zh., Vol. 4, No. 3, 223-32 (1958). In Russian.

The variations with frequency of the active and reactive components of the specific electric impedance are calculated and given in graphical form, also the frequency variations of sound pressure for constant current and for constant voltage for ideal piston-type quartz or barium titanate transducers working in water. Transducer materials are probably best rated by the ratio of the active to the reactive resistance. It is also shown in the paper that for narrow band emitters, materials should be selected with large piezomodulus, large density and large elasticity modulus. [English translation in: Soviet Physics — Acoustics (New York), Vol. 4, No. 3, 227-36 (July-Sept., 1958)].

C.R.S.Manders

534.232

5463. PRODUCTION OF HIGH-INTENSITY ULTRASOUND IN LIQUIDS. A.K.Burov.

Akust. Zh., Vol. 4, No. 4, 315-20 (1958). In Russian.

The paper describes apparatus which can produce more than 300 W/cm^2 continuously at 1.5 Mc/s, and 400 μsec pulses (at 625 c/s repetition frequency) stronger than 500 W/cm^2 , over an area greater than 40 cm^2 . A 35-100 mm diameter quartz plate immersed

in transformer oil is excited by a 30 kW valve generator. The apparatus is capable of producing square u.s. pulses of 100 to 3000 μ sec duration and 100 c/s to 20 kc/s repetition frequency. The unfocused ultrasonic beam produced was found to consist of two parts: an effective beam and a surrounding scattering zone without a sharp boundary between these parts. A.Tybulewicz

534.232

5464. COMMENT ON A.A.SENKEVICH'S LETTER TO THE EDITOR "EFFECT OF THE FINITE AMPLITUDE OF AN ACOUSTIC RADIATOR ON THE WAVE-FORM". A.A.Tuzhilin. Akust. Zh., Vol. 4, No. 4, 371-2 (1958). In Russian.

Critical remarks about "erroneous assumptions leading to wrong results" in Senkevich's letter (Abstr. 6764/1958).

534.24

5465. ON THE SOUND WAVE REFLECTED BY A SPHERE STRUCK BY A SOUND PULSE. M.Federici. Ricerca sci., Vol. 28, No. 8, 1659-67 (Aug., 1958). In Italian.

The sound reflection produced by a totally reflecting sphere of radius r which is struck by a pressure wave of the type

$$p_1 = \frac{p_0}{R} e^{j(\omega t - KR + \frac{\pi}{2})} [\text{Heaviside Function}]$$

is calculated. From the formulae giving the reflected pressure for a sphere struck by a sinusoidal sound wave the author obtains the functional operator expressing the ratio between the reflected and the incident wave and evaluates it by an approximation method. It is shown that the reflected sound wave can be considered as due to three partial reflections. The first is due to the harmonics of the function having $\lambda < 0.2 r$, which are reflected as soon as the sound wave impinges on the sphere. The second is due to the harmonics having $r > \lambda > 0.2 r$, which are totally reflected when the wave reaches a surface on the sphere having a diameter $0.75 r$. The third is due to the waves having $\lambda > r$, which are partially reflected when the wave reaches the centre of the sphere. The total reflected sound wave is an oscillating pulse which is considerably attenuated after the sound wave has passed the sphere.

534.26 : 535.42

5466. EFFECT OF FLUCTUATIONS IN THE INCIDENT WAVE ON THE DISTRIBUTION OF MEAN INTENSITY NEAR THE FOCUS OF A LENS. M.N.Krom and L.A.Chernov. Akust. Zh., Vol. 4, No. 4, 341-7 (1958). In Russian.

The lens considered is an aberrationless objective which transforms a plane wave into a convergent spherical wave. The fluctuations in the incident wave are assumed to be due to statistical variations of the refractive index of the medium traversed by the wave. The cases of very small and very large fluctuations were dealt with earlier by Chernov (Abstr. 4815/1958). The present paper extends Chernov's treatment to fluctuations of arbitrary amplitude and gives the distribution of the mean intensity near the focus of the objective described in the form of a series. The results are shown graphically; they can be applied both to optical and to acoustic waves.

A.Tybulewicz

534.26

5467. DIFFRACTION OF SOUND WAVES IN CONVERGING BEAMS. B.D.Tartakovskii. Akust. Zh., Vol. 4, No. 4, 355-60 (1958). In Russian.

The paper considers diffraction of sound waves at the focus of a system with a non-uniform amplitude distribution over the wave-front, with wave aberration and a large angle of aperture. The acoustical system considered may also have dimensions comparable with the acoustic wavelength. It is found that the amplitude fluctuations at distances greater than one wavelength do not affect the diffraction image very much. The field on or near the axis of an acoustic beam is considered as a special case.

A.Tybulewicz

534.26

5468. A MODIFICATION OF AN ULTRASONIC INTERFEROMETER. A.A.Isaev, I.G.Mikhailov and A.S.Khimunin. Akust. Zh., Vol. 4, No. 4, 363-4 (1958). In Russian.

The Cady-Pearson interferometer is modified by the use of two quartz plates: one is the vibrator and the other serves as the stabilizing element. The modified instrument has high stability at all positions of the interferometer reflector, is very sensitive, and can be used in liquids. A.Tybulewicz

534.26 : 538.566

SCATTERING CROSS-SECTIONS OF A SPHERE AND A CYLINDER. See Abstr. 4846

534.321.9 : 535.42

DIFFRACTION OF LIGHT BY SUPERPOSED PARALLEL SUPERSONIC WAVES. GENERAL THEORY. See Abstr. 4485

534.39 : 535.373

ON THE STIMULATION EFFECT OF SLOWLY DECAYING PHOSPHORS IN THE ULTRASONIC FIELD. See Abstr. 4469

534.39 : 539.32

DYNAMIC MECHANICAL PROPERTIES OF POLYVINYL STEARATE AT AUDIO-FREQUENCIES. See Abstr. 5192

534.7

PHYSIOLOGICAL ACOUSTICS. HEARING. See also the Section entitled "BIOPHYSICS. PHYSIOLOGICAL PHYSICS".

534.843

5469. APPARATUS FOR MEASUREMENT OF ARTICULATION IN ROOMS. E.E.Golikov. Akust. Zh., Vol. 4, No. 4, 362-3 (1958). In Russian.

The articulation quality of a room may be found by measuring the useful acoustic energy density (received during the first 50-60 sec), the interfering acoustic energy density (received after the first 50-60 sec) and the reverberation time. Apparatus is described which measures the latter three quantities. The articulation quality of a room of 920 m³ volume deduced from the measurements with this apparatus was found to be within 5-6% of the articulation obtained by using syllable tables. A.Tybulewicz

534.844

5470. DIRECT MEASUREMENT OF THE ACOUSTIC RATIO. W.R.Stroh. J. Acoust. Soc. Amer., Vol. 31, No. 2, 234-8 (Feb., 1959).

A direct measurement of the acoustic ratio Q -- i.e., the ratio of reverberant sound energy density in an enclosure to the direct sound energy density -- by a correlation technique is shown to be possible. Results of such measurements in several rooms are found to agree fairly well with values obtained from the reverberation time through the formula $Q = 4\pi TR^2/13.8 V$, which is based on the Sabine theory of the diffuse reverberant sound field.

OPTICS . SPECTRA . LUMINESCENCE

535.135 : 548.732

5471. GROUP VELOCITY, ENERGY FLOW DENSITY AND ENERGY DENSITY IN THE X-RAY (OR LIGHT) OPTICS OF CRYSTALS. E.H.Wagner. Z. Phys., Vol. 154, No. 3, 352-60 (1959). In German.

In studying the propagation of X-rays (or visible light) in perfect crystals, the well-known expression for the group velocity vector can be used and interpreted in terms of the dispersion (or index) surface. The group velocity vector, being normal to the dispersion surface in the point representing the appropriate wavefield, is shown to be proportional to the average of the Poynting vector observable macroscopically. The factor occurring in this relation is the averaged energy density of the electromagnetic field, which differs from the usual expression, by a term proportional $\partial\epsilon/\partial\nu$, as a consequence of the frequency dependence assumed for the dielectric tensor ϵ .

535.214.4

5472. HIGH-SPEED INFRARED RADIOMETERS. R.W.Astheimer and E.M.Wormser. J. Opt. Soc. Amer., Vol. 49, No. 2, 179-83 (Feb., 1959).

The paper describes high-speed infrared radiometers utilizing thermistor infrared detectors. Instruments with 4 and 8 in. diam. Cassegrain mirror optics are described. The method of operation and the calibration of these radiometers is discussed. The radiometers are uniformly sensitive from 0.7 to 35 μ . They have a response time of 16 msec and a sensitivity of the order of 10^{-10} W/cm⁻² corresponding to a blackbody temperature differential of 0.01 deg C. The radiometers are used for quantitative measurements of infrared radiation and remote temperature determinations.

5473. INSTRUMENT FOR THERMAL PHOTOGRAPHY. R.W.Astheimer and E.M.Wormser. *J. Opt. Soc. Amer.*, Vol. 49, No. 2, 184-7 (Feb., 1959).
The paper described an instrument for taking thermal photographs utilizing infrared radiation passively emitted by objects at ambient temperature. The instrument consists of an 8-in. radio-meter utilizing thermistor infrared detectors and an imaging attachment. A glow modulator forms a thermal photograph on Polaroid or conventional film. Quantitative analysis of thermal photographs is described, and several examples of thermal photographs are given.
5474. A PULSED U.V. DOSIMETER. W.Eschke. *Exper. Tech. der Phys.*, Vol. 4, No. 4, 157-9 (1956). In German.
A CdS cell is connected in series with a capacity, and the circuit fed with an adjustable potential. Light incident on the cell causes the condenser to charge and eventually to strike-over a glow lamp placed in parallel with it. The flash frequency for a given applied voltage is proportional to the incident u.v. light intensity. A known leak can be switched in to calibrate the circuit. For low intensities the response is approximately linear; thereafter it becomes exponential. X-ray or γ -ray sources could be substituted.
5475. OPTICAL UNIT FOR REFLECTION DENSITOMETRY. A.J.Derr. *J. Opt. Soc. Amer.*, Vol. 49, No. 2, 176-8 (Feb., 1959).
An optical unit for the measurement of reflection density is described. In conjunction with a sensitive densitometer, optical densities up to 4.0 can be measured with highly selective spectral filtration. The unit utilizes 45° incident radiation with measurement of normally reflected radiation as specified for use with photographic materials. The stray light level amounts to less than 1 part in 100 000, and the unwanted specular radiation to less than 1 part in 10 000. Problems in the design and evaluation of this unit are reviewed.
5476. ON PHOTOMETRY IN THE EXTREME ULTRAVIOLET WITH FLUORESCENCE SENSITIZED PHOTOGRAPHIC MATERIAL. H.Greiner. *Z. Naturforsch.*, Vol. 12a, No. 9, 735-8 (1957). In German.
Agfa X-ray film is sensitized with sodium salicylate and its sensitivity and resolving power compared with Kodak SWR film for the short ultraviolet region. The sensitivity is effectively independent of wavelength over the short ultraviolet region and improves on the Kodak film in the example given of spectra photographed at 760 Å.
5477. BI-FILTER PHOTOMETER FOR CLINICAL AND ANALYTICAL CHEMISTRY. E.Jung, H.Plesse and A.Reule. *Z. InstrumKde*, Vol. 66, No. 7, 138-45 (July, 1958). In German.
A detailed description is given of the construction and operation of the ELKO II instrument.
5478. MEASUREMENT OF LOW LIGHT LEVELS BY THE PHOTON COUNTING METHOD. B.M.Young and L.P.Cooper. *Trans Illum. Engng Soc.*, Vol. 24, No. 1, 46-50 (1959).
Experiments are described using electron counting techniques for measuring low light levels with photomultipliers. An accuracy of 1% has been achieved in measuring cathode currents of the order of 10^{-15} A or less with the photomultiplier cooled to -183°C . The luminous flux falling on the cathode of area 2.4 in^2 was about 10^{-11} lumen. At higher levels, the limitations in resolution of the counting equipment available caused 20% loss in counts at cathode currents of 10^{-13} to 10^{-14} A. The limitations of the technique for photometric applications are discussed, together with the statistical considerations governing the resolution times necessary for the amplifier and counting circuits in order to increase the range over which the counts are proportional to the luminous flux incident on the cathode.
5479. DETERMINATION OF THE [LONGITUDINAL] SPHERICAL ABERRATION IN CATOPTRICAL SYSTEMS WITH ONE ARBITRARY SURFACE OF REVOLUTION. K.Stiegler. *Optik*, Vol. 16, No. 3, 132-4 (March, 1959). In German.
5480. INTERFEROMETRIC MEASUREMENT OF FREQUENCY RESPONSE, WITH AUTOMATIC RECORDING. D.Kelsall. *Acta electronica*, Vol. 2, No. 1-2, 266-70 (1957-58).
"Physical problems of colour television" Conference paper (see Abstr. 1006/1958). A double beam shearing interferometer, with corner-cube reflectors is used, with which the spatial phase shifts can also be recorded automatically. The frequency response curves for a well-corrected lens in different focal planes, have been compared with results obtained theoretically. The influence of spherical aberration on the frequency response has also been studied, in certain cases.
5481. THE INFLUENCE OF SPHERICAL AND CHROMATIC ABERRATION ON THE FREQUENCY RESPONSE OF A LENS. A.M.Goodbody. *Acta electronica*, Vol. 2, No. 1-2, 274-6 (1957-58). In French.
"Physical problems of colour television" Conference paper (see Abstr. 1006/1958). A method of numerical integration suitable for the evaluation of oscillatory functions is briefly described. This has been programmed for the English Electric "Deuce" computer. Frequency response curves have been calculated for different states of correction in different planes of focus.
5482. APODIZATION AND FREQUENCY RESPONSE IN INCOHERENT LIGHT. J.A.Macdonald. *Acta electronica*, Vol. 2, No. 1-2, 277-8 (1957-58).
"Physical problems of colour television" Conference paper (see Abstr. 1006/1958). A study has been made of the possibility of improving the frequency response of a camera lens by means of apodization. The frequency response function is equal to the ratio of two integrals involving the transparency function; by the usual methods of the calculus of variations, the condition for maximization of frequency response for variation of transparency is expressed as a functional equation, which in turn may be approximated to by a linear second-order differential equation for the transparency with two boundary conditions.
5483. INTERFEROMETRIC STUDY OF THE FOURIER SPECTRUM OF THE PHOTOGRAPHIC IMAGE. J.C.Viénot. *Acta electronica*, Vol. 2, No. 1-2, 279-82 (1957-58). In French.
"Physical problems of colour television" Conference paper (see Abstr. 1006/1958). The problem is essentially to determine how spatial frequencies transmitted through camera lenses impress photo-sensitive film or plate and to evaluate the relative amplitudes of frequency components recorded. Definition of the energy transparency spectrum of the photographic recording can be obtained by superimposing the sine-wave function given by a Michelson interferometer. For different frequencies of the linear fringe pattern the intensity transmitted by a finite element of the recording is integrated. The signal response of a photomultiplier pickup cell provide transmission versus frequency curves.
5484. THE EFFECT OF APERTURE ABERRATIONS ON IMAGE QUALITY. J.Focke. *Optica Acta*, Vol. 4, No. 1, 17-21 (March, 1957). In German.
The distribution of light in the images of edges, strips and gratings in the presence of spherical aberration is calculated using wave theory. Its effect on image quality is illustrated.
5485. THE EFFECT OF PARTIALLY COHERENT LIGHT ON THE FORMATION OF IMAGES OF CERTAIN OPAQUE, EXTENDED OBJECTS. D.Canals-Frau and M.Rousseau. *Optica Acta*, Vol. 5, No. 1-2, 15-27 (March-June, 1958). In French.
Formulae are obtained for the intensity and contrast of the images. The images of an opaque line, an edge and an opaque disk are considered as a function of the degree of coherence of the illumination. Imagery free from aberration and monochromatic light is assumed in all cases.

THE IRIS-DIAPHRAGM BENCH PHOTOMETER OF THE BASLE OBSERVATORY. See Abstr. 5299

5486. FORMATION OF IMAGES OF OBJECTS, IN A FIELD WHICH IS BRIGHTER OR DARKER THAN THE OBJECTS THEMSELVES, BY AN ABERRATIONLESS OPTICAL SYSTEM. L.P.Moroz.

Optika i Spektrosk., Vol. 5, No. 6, 692-8 (1958). In Russian.

The object is a band in a field which is either brighter or darker than the object itself. This object is imaged by an aberrationless optical system with a circular aperture. The author obtains an equation which relates the object width, its contrast with the surrounding field, the contrast between a point on the object axis and the surrounding field, the aperture of the optical system and the wavelength used. This equation makes it possible to find the limiting values of each of the listed quantities, when the other quantities are given, as a function of the limit of sensitivity to contrast of the receiver used. The form of this equation depends on whether the object is darker or brighter than the field for a given contrast of the object with the field. Several special cases are considered.

A.Tybulewicz

5487. A LENS-TESTING APPARATUS. K.G.Birch.

Acta electronica, Vol. 2, No. 1-2, 271-3 (1957-58).

"Physical problems of colour television" Conference paper (see Abstr. 1006/1958). The intensity profile of the image of an incoherently illuminated slit can either be measured directly, or its Fourier transform determined by means of a scanning-filter. In the first case, the frequency response is obtained by calculation, using Whittaker's interpolation theorem; in the second, a variable-velocity drum carrying equally spaced slits scans the images, the output from a photo-multiplier then being detected using a narrow band electrical filter of fixed frequency. Varying the speed of rotation of the drum then corresponds to filtering different spatial frequencies from the slit-image.

5488. EVALUATION OF LENS DISTORTION BY VISUAL AND PHOTOGRAPHIC METHODS.

F.E.Washer, W.P.Tayman and W.R.Darling.

J. Res. Nat. Bur. Stand., Vol. 61, No. 6, 509-15 (Dec., 1958).

Measurements made on a single lens using the two methods are reported. The precision of measurement of each method is determined which shows that the observed differences must be attributed to systematic error. Various sources of systematic error are considered. Uncompensated differential plate tipping is identified as the most probable cause of the observed differences. A method of correction is developed. It is concluded that when work is done with extreme care and with due account taken of various insidious sources of error, it is possible to achieve comparable results with either method.

5489. STOKES' EQUATIONS AND THEIR APPLICATION TO THE REFRACTIVITY OF THIN FILMS. A.F.Wickersham, Jr.

J. Opt. Soc. Amer., Vol. 48, No. 12, 958-64 (Dec., 1958).

A solution to the problem of determining the refractivity of n identical planar arrays from the properties of a single array is obtained by first extending Stokes' equations to a form appropriate to a microscopic situation and then appropriately modifying Crook's results for thin films. The results of such development are found to be in agreement with data taken at microwave frequencies.

5490. ON THE POSSIBILITY OF MEASURING REFRACTIVE INDICES OF CRYSTALLINE SUBSTANCES WITH AN ABBE REFRACTOMETER. F.Nechai.

Zh. tekhn. Fiz., Vol. 27, No. 9, 2184-5 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 9, 2025-6 (Sept., 1957).

The note explains in greater detail certain practical aspects of work described in Abstr. 8648 (1956). The method of covering the prism is described and the value of the method in determining changes of index near phase transitions is emphasized.

R.W.Fish

5491. OPTICAL INDICES OF REFRACTION OF WO_3 .

S.Sawada and G.C.Danielson.

Phys. Rev., Vol. 113, No. 4, 1008-13 (Feb. 15, 1959).

A modified Chaulnes' method using polarized light has been developed to measure the indices of refraction of WO_3 . By this method, the three principal indices of refraction of a crystal were

obtained by observations in the direction of only one optic principal axis. For WO_3 , the mean value of the indices of refraction and the maximum value of birefringence at room temperature were found to be 2.5 and 0.42, respectively. The crystals were positive below $740^\circ C$ and negative above this temperature. Distinct anomalies in the indices of refraction were observed at $330^\circ C$ and $740^\circ C$. The results are compared with those for some other perovskite-type ferroelectrics and antiferroelectrics.

5492. ATOMIC STANDARDS OF LENGTH AND TIME.

H.Barrell and L.Essen.

Sci. Progr., Vol. 47, 209-29 (April, 1959).

Comprehensive review. 31 references.

REINFORCEMENT OF SPECTRAL LINES OBTAINED BY CONTACT FROM NEGATIVES MADE RADIOACTIVE.

See Abstr. 5288

5493. AN ELECTRONIC SPARK-GENERATOR WITH HIGH EXCITATION ENERGY AND STABILITY. F.Leutwein.

Exper. Tech. der Phys., Vol. 1, No. 4-5, 173-80 (Nov.-Dec., 1953).

In German.

The theoretical and experimental work of Kaiser (Abstr. 4326/1951) is used for the construction of the spark generator, consisting of an impulse generator, amplifier and final stage. For an a.c. input of about 6 kW, impulses of 2 MW of 0.1-2 μ sec duration are produced.

C.Turner

5494. COMPARATIVE EXPERIMENTS FOR SPECTRAL ANALYSIS WITH THE IMPULSE SPARK GENERATOR.

L.Doerffel-Sachsse and F.Leutwein.

Exper. Tech. der Phys., Vol. 1, No. 4-5, 180-92 (Nov.-Dec., 1953).

In German.

The impulse spark generator (see preceding abstract) is compared with the Zeiss FF20 impulse generator. Excitation constants are found for light metals and steel probes. Calibration curves are found for several alloy components in light metals and steel, and for spectra of solutions.

C.Turner

5495. METHOD OF INCREASING THE SPEED OF A GRAZING-INCIDENCE SPECTROGRAPH. W.A.Rense and T.Violett.

J. Opt. Soc. Amer., Vol. 49, No. 2, 139-41 (Feb., 1959).

The speed of a grazing-incidence type concave grating spectrograph in the extreme ultraviolet can be increased appreciably by the use of a suitable toroidal focusing mirror placed before the slit so as to receive the light from the source at grazing-incidence. The radii of the toroidal mirror are chosen so that its first (horizontal) astigmatic image falls on the slit and its second (vertical) astigmatic image falls beyond the grating. Increased aperture and reduced astigmatism for the spectrograph as a whole are thus achieved. The elementary theory is developed and sample spectrograms presented.

5496. CORRECTION FOR INSTRUMENTAL DRIFT IN FLAME PHOTOMETRY. B.W.Mulligan and A.F.Haught.

J. Res. Nat. Bur. Stand., Vol. 61, No. 6, 499-501 (Dec., 1958).

The application of the principles of experimental design to correct for drift in instrumental measurements, specifically in flame photometry, is described. Based on the procedure proposed by Youden, samples and reference standards may be measured in combinations of pairs in a manner such that errors caused by drift can be minimized and the actual amount of drift can be determined. Where the drift is dependent on the magnitude of the quantity measured, grouping by magnitude prior to final measurement is necessary. Application of the procedure to flame photometric determination of alkali elements, under conditions of severe drift, resulted in improving coefficients of variation from an original range of 2.0 to 3.5 to a range of 0.6 to 1.2.

5497. ON ERRORS IN COLLIMATION. M.S.Sodha.

Optik, Vol. 16, No. 3, 150-4 (March, 1959).

An investigation of the broadening effects due to an error in collimation, together with a calculation of the maximum permissible error in collimation.

5498. A NEW TYPE OF SPECTROMETER: THE GRATING INTERFEROMETER. P. Connes.

Optica Acta, Vol. 4, No. 4, 136-44 (Dec., 1957). In French.

A Michelson interferometer whose mirrors are replaced by gratings acts as a spectrometer since it modulates a spectral element whose width is equal to the theoretical resolution limit of the grating. It at the same time accepts a beam of much larger solid angle than would be possible with a classical spectrometer, thus giving an important increase of luminosity, chiefly useful in the infrared.

535.33.07 : 522.6

AN AURORAL SPECTROGRAPH. See Abstr. 5296

535.331

5499. THE SERIES $4p^{m-1}ns$ IN THE SPECTRA Ga I TO Rb I AND Ge II TO Sr II. M.A. Catalán and F.R. Rico. An. Real Soc. Espan. Fis. Quim., Vol. 54(A), No. 9-10, 301-8 (Sept.-Oct., 1958). In Spanish.

Regularities between the levels, terms and limits for the configurations $4p^{m-1}5s$, $4p^{m-1}6s$ are discussed. The calculated values are given for some levels, and a number of perturbations are indicated. The following values of ionization potentials differ from those given by Moore (1958), Se II 21.19, Kr II 24.36, Rb II 27.30 eV.

R. F. Barrow

535.332 : 539.18

5500. TERM ANALYSIS OF THE SECOND SPECTRUM OF RHENIUM (Re II). W. F. Meggers, M. A. Catalán and M. Sales. J. Res. Nat. Bur. Stand., Vol. 61, No. 6, 441-61 (Dec., 1958).

Wavelengths and estimated intensities of approximately 2000 spectral lines were available for this analysis. Observed Zeeman patterns for 220 Re II lines facilitated finding and interpreting the first energy levels. The analysis continued until 49 low-even, and 85 high-odd levels were found. Transitions between these groups of levels account for 1014 Re II lines including about 70% of the total observed intensity. The ground state of Re^+ is described by the spectral term $5d^5(a^6S)6s a^7S_3$.

535.332

5501. THE SPECTRUM OF SINGLY IONIZED ARGON IN THE VACUUM ULTRAVIOLET. L. Minnhagen. Ark. Fys., Vol. 14, Paper 13, 483-95 (1958).

The spectrum was investigated with a 1.5 m concave-grating grazing-incidence spectrograph. The excitation was made by high-frequency pulses using previously described arrangements (Abstr. 5762/1958). About 150 lines were observed and identified in the Schumann region, the majority being $(^3P)3d-(^3P)4f, 5f, 6f$ lines. There are also several $(^3P)4s, 3d-(^3P)5p$ and $(^3P)4p-(^3P)6d$ lines as well as $(^3P)3d-(^1D)4f$ and $(^1D)3d-(^1D)4f, 5f$ lines. New transitions to the $3p^6\ ^2S$ level were also observed. In the region below 762 Å, additional transitions to the ground term were identified. From an accurate energy level scheme, based on the author's extensive measurements at longer wavelengths and fixed in relation to the ground term by using Herzberg's very accurate measurements in the vacuum ultraviolet, the wavelengths of about 70 Å II lines, well suited as standards, have been computed. Below 762 Å they should be accurate to ± 0.0005 Å.

535.332

5502. SPECTRA EMITTED FROM SOLID NITROGEN CONDENSED AT VERY LOW TEMPERATURES FROM A GAS DISCHARGE. M. Peyron and H. P. Broida. J. chem. Phys., Vol. 30, No. 1, 139-50 (Jan., 1959).

Solid products from electrical discharges containing nitrogen emit visible light at temperatures below $40^\circ K$. The observed spectra depend greatly upon (1) the temperature at which the discharge products are condensed, (2) the rate of deposition of the gas, (3) the addition of small amounts of impurities, and (4) the addition of large amounts of inert gases. The effect of these parameters is surveyed, in order to understand better the mechanisms responsible for the various types of radiation which are observed.

535.332

5503. EXPERIMENTAL DETERMINATION OF OSCILLATOR STRENGTHS OF SOME N II AND O II LINES. F. Mastrup and W. Wiese.

Z. Astrophys., Vol. 44, No. 4, 259-79 (1958). In German.

The spectra of some lines from a discharge with temperature about $20,000^\circ K$ were photographed and the oscillator strengths (f) determined from the intensities. The f values could be calculated for some of the lines; tables of calculated and measured values are

given. The method of comparison with the known f values for He is also used with He-N and He-O mixtures. G. F. Lothian

535.333

5504. ROTATIONAL ANALYSIS OF THE ULTRAVIOLET BAND SYSTEM OF CS.

A. Lagerqvist, H. Westerlund, C. V. Wright and R. F. Barrow. Ark. Fys., Vol. 14, Paper 24, 387-408 (1958).

Twenty-four bands were analysed. The system arises from a transition $A\ ^1\Pi-X\ ^1\Sigma^+$. A number of perturbations are observed in the upper state arising from interactions with a $^3\Sigma^+$ and a $^5\Sigma^+$ state. At least two singlet perturbing states were also recognized. For the states $e^3\Sigma^+$, $a^1\Sigma^+$, $A\ ^1\Pi$ and $X\ ^1\Sigma^+$, the following constants were derived: T_0 , ω_e , $\omega_e x_e$, B_e and a_e . The dissociation energy, $D_{298}^\circ(CS)$, is 175 ± 7 kcal/mole.

535.333

5505. WALL EFFECTS ON ROTATIONAL POPULATION OF $OH^2\Sigma^+$ IN A MICROWAVE DISCHARGE.

T. Carrington and H. P. Broida.

J. molecular Spectrosc., Vol. 2, No. 3, 273-86 (June, 1958).

A study is presented of the rotational intensity distribution in the $^2\Sigma^+-^2\Pi$ electronic transition of OH radicals excited in electrodeless discharges through argon containing about one-half percent water vapour, at a total pressure of 0.05 mm Hg. Two independent rotational distributions appear, their relative importance depending on the temperature of the wall of the discharge tube, the density of power dissipation in the discharge, and on the frequency of the exciting field. In the sensitivity of the spectrum to changes in discharge conditions, the wall plays a determining role.

535.333

5506. BAND SPECTRA OF IODINE, CHLORINE AND BROMINE IN THE SPECTRAL REGION 2400-1400 Å.

P. B. V. Haranath and P. Tiruvenganna Rao. J. molecular Spectrosc., Vol. 2, No. 5, 428-63 (Oct., 1958).

A study was made of the emission bands of iodine, chlorine and bromine in the spectral region 2400-1400 Å. Several new band systems were observed and a vibrational analysis of these bands was attempted. In all the band systems analysed, the lower state was identified as the ground electronic state of the particular molecule. The nature and properties of all the stable electronic levels of these molecules are discussed in terms of the electron configurations and more complete term schemes are presented.

535.333

5507. EXTENSION OF THE $A\ ^3\Pi-X\ ^3\Sigma^-$ SYSTEM OF OH^+ . S. Weniger and R. Herman.

J. Phys. Radium, Vol. 19, No. 6, 582-9 (June, 1958). In French.

A strong emission spectrum of the OH^+ molecule together with that of the OH radical and of the H atom were photographed in the near ultraviolet. The rotational structure of the (1,1) 3695 Å, (2,2) 3830 Å and (3,3) 3958 Å bands of the $^3\Pi-^3\Sigma$ transition of OH^+ has been analysed. The Λ and multiplet splittings of the $^3\Pi$ level were measured and the values of the vibrational and rotational constants improved.

535.333

5508. NEW BANDS OF THE CF MOLECULE.

Yu. Ya. Kuzyakov and V. M. Tatevskii.

Optika i Spektrosk., Vol. 5, No. 6, 699 (1958). In Russian.

Andrews and Barrow (Abstr. 6112/1951) found only 4 bands belonging to the $A^2\Sigma-X^2\Pi$ transition of the CF molecule: (0,0), (0,1), (1,0), (1,1). Other bands of this system could not be observed because of strong overlapping by complex bands of the CF_2 molecule. Under more stable conditions of an electric discharge through a stream of CF_4 vapour, the present authors were able to decrease considerably the CF_2 band intensities and to measure 9 more bands of the $A^2\Sigma-X^2\Pi$ transition between 35 500 and 40 300 cm^{-1} .

A. Tybulewicz

535.333

5509. WAVELENGTHS FROM THORIUM-HALIDE LAMPS.

W. F. Meggers and R. W. Stanley.

J. Res. Nat. Bur. Stand., Vol. 61, No. 2, 95-103 (Aug., 1958).

Quartz-tube lamps containing a small quantity of a thorium halide, when excited by microwaves, emit thousands of uniformly sharp and evenly distributed lines whose wavelengths, or positions in a spectrum, can be determined with about one-tenth the error of locating iron-arc lines. Preliminary values of 222 vacuum wavelengths emitted by a thorium-iodide lamp have been measured relative to 5462.2705 and 4047.7144 Å emitted by a similar lamp containing mercury-198. Fabry-Perot interferometers with plate

separations of 25, 40, or 50 mm were used with a stigmatic grating spectrograph in making these measurements. The thorium wavelengths range from 3288.7356 to 6991.5839 Å in vacuum, and from 3287.7885 to 6989.6562 Å in standard air. The accuracy in relative value of 27 classified thorium lines is tested by means of the combination principle, which indicates that the average error is less than 1 part in 20 million.

535.333

5510. THE MOLECULAR SPECTRUM OF HYDROGEN AND ITS ISOTOPES. G.H.Dieke.

J. molecular Spectrosc., Vol. 2, No. 5, 494-517 (Oct., 1958).

The spectra of all six known isotopic species of molecular hydrogen, H_2 , DH , D_2 , TH , TD , T_2 , were obtained with high dispersion under several excitation conditions. This has led to a complete wavelength table of these spectra containing about 100 000 different lines. The principal band systems were found in all six spectra and a comparison of the isotopes has resulted in the clarification of many previously doubtful points. A complete table of all known H_2 -levels is included.

535.333

5511. THE $C^2\Sigma^+-A^2\Sigma^+$ -BAND SYSTEM OF OH. A.Michel.

Z.Naturforsch., Vol. 12a, No. 11, 887-96 (1957). In German.

The spectrum emitted by discharge through streaming water vapour is photographed. Bands are found at 2545, 2465, 2333 and 2248 Å, the wavenumbers of the rotational lines are tabulated with the corresponding transitions. Spectrograms of a new emission for H_2O and D_2O in the region 1700-1900 Å are reproduced and briefly discussed.

G.F.Lothian

535.338.334

5512. GENERAL IMPACT THEORY OF PRESSURE BROADENING. M.Baranger.

Phys. Rev., Vol. 112, No. 3, 855-65 (Nov. 1, 1958).

The work of two previous papers is extended (Abstr. 1271-2/1959) and a theory of pressure broadening is developed which treats the perturbers quantum mechanically and allows for inelastic collisions, degeneracy, and overlapping lines. The impact approximation is used. It consists in assuming that it takes, on the average, many collisions to produce an appreciable disturbance in the wave-function of the atom, and it results in an isolated line having a Lorentz shape. Validity criteria are given. When the approximation is valid, it is allowable to replace the exact, fluctuating interaction of the perturbers with the atom by a constant effective interaction. The effective interaction is expressed in terms of the one-perturber quantum mechanical transition amplitudes on and near the energy shell and its close relationship to the scattering matrix is stressed. The calculation of the line shape in terms of the effective interaction is the same as when the perturbers move on classical paths. Results are written explicitly for isolated lines. If the interaction of the perturbers with the final state can be neglected, the shift and width are proportional to the real and imaginary part of the forward elastic scattering amplitude, respectively. By the optical theorem, the width can also be written in terms of the total cross-section. When the interaction in the final state cannot be neglected, the shift and width are still given in terms of the elastic scattering amplitudes, in a slightly more complicated fashion. Rules are given for taking into account rotational degeneracy of the radiating states.

535.338.334

5513. THE PROFILE OF BALMER LINES UNDER THE INFLUENCE OF ELECTRON AND ION COLLISIONS. G.Ecker.

Z.Naturforsch., Vol. 12a, No. 6, 517-18 (1957). In German.

The Holtsmark statistical theory of line broadening includes only the effect of positive ions. In certain conditions this simplified treatment is unjustified and allowance for electron density effects must be made. The author discusses such electron effects and quotes calculated profiles for $H\beta$. The temperature effect is also treated.

J.D.Craggs

535.34.07

5514. THREE NEW SPECTROPHOTOMETERS. E.Lüscher.

Appl. Spectrosc., Vol. 12, No. 6, 172-4 (1958).

Brief descriptions of Swiss commercial instruments for absorption measurements: (1) uses a continuously adjustable interference filter for spectral separation in the range 4000-7000 Å; (2) a Littrow instrument with ultraviolet transparent glass (3000 to 7000 Å); (3) an instrument with prism or grating (range 2100 Å-5 μ).

G.F.Lothian

535.34.07

5515. ON THE DESIGN OF AN ABSORPTION CELL.

M.S.Sodha and S.S.Mitra.

Optik, Vol. 16, No. 3, 146-9 (March, 1959).

The problem of designing an absorption cell for obtaining a maximum contrast in the spectrum is discussed. The term "contrast" is defined as $(I_B - I_T)/I_0$, where I_B is the background energy transmitted, and I_0 the incident intensity. The best condition for getting a maximum contrast is shown to be

$$(n\kappa)_{\max} = \frac{\log \alpha - \log \beta}{\alpha - \beta},$$

where n is the number of absorbing centres (atoms or molecules) per cm^3 , κ the path length, and α and β are the extinction coefficients for the characteristic and background absorptions. An example is given showing the calculation for obtaining an optimum cell size.

535.343

5516. THE ABSORPTION OF WATER SOLUTIONS OF EUROPIUM NITRATE. F.Bayer-Helms.

Z.Naturforsch., Vol. 13a, No. 2, 161-9 (Feb., 1958). In German.

The europium absorption bands ${}^7F_0 \rightarrow {}^5D_{0,1,2}$ were studied at various concentrations and temperatures with or without an excess of nitrate. It was then possible to analyse the absorption spectrum into four parts which could be associated to the four steps in the dissociation of Eu.

L.Pincherle

535.343

5517. ON THE FREE-ELECTRON THEORY OF ABSORPTION SPECTRA OF SOME LINEAR CONJUGATED SYSTEMS.

S.Olszewski.

Acta phys. Polon., Vol. 16, No. 3, 211-26 (1957).

The method of antisymmetrized free-electron molecular orbitals was applied to calculate the absorption maxima in the spectrum of symmetrical cyanine dyes and polyenes. The results are discussed in comparison with experimental data and data on the simple free-electron model. In the case of cyanines, considerable improvement of the theoretical values is obtained by introducing the resonance barrier in the free-electron model. The height of this barrier is determined by the stabilization energies of the cyanine nuclei. The effect of the energy states obtained by the introduction of the barrier to the simple free-electron model is discussed in detail and the correspondence between the results of resonance theory for cyanines and those of a free-electron model with a barrier indicated.

535.343 : 541.14

5518. EFFECT OF RING SIZE ON THE FAR ULTRAVIOLET ABSORPTION AND PHOTOLYSIS OF CYCLIC ETHERS.

G.Fleming, M.M.Anderson, A.J.Harrison and L.W.Pickett.

J. chem. Phys., Vol. 30, No. 2, 351-4 (Feb., 1959).

Absorption curves, tabulated extinction coefficients, and oscillator strengths are given for trimethylene oxide, ethylene oxide, and formaldehyde vapour in the spectral range 2000-1550 Å. The spectra and photochemical stability of these compounds are compared with those of previously determined five- and six-membered ring ethers.

535.343

5519. ABSORPTION OF ACYCLIC OXYGEN COMPOUNDS IN THE VACUUM ULTRAVIOLET. I. ALCOHOLS.

A.J.Harrison, B.J.Cederholm and M.A.Terwilliger.

J. chem. Phys., Vol. 30, No. 2, 355-6 (Feb., 1959).

A fluorite prism vacuum spectrograph and a hydrogen lamp were used to determine the 50 000 to 65 000 cm^{-1} absorption spectra of water, methanol, ethanol, 1-propanol, and 2-propanol in the vapour phase at 22°C.

535.343

5520. ABSORPTION OF ACYCLIC OXYGEN COMPOUNDS IN THE VACUUM ULTRAVIOLET. II. ETHERS.

A.J.Harrison and D.R.W.Price.

J. chem. Phys., Vol. 30, No. 2, 357-60 (Feb., 1959).

For Pt I, see preceding abstract. The 45 000 to 65 000 cm^{-1} absorption spectra of dimethyl ether, diethyl ether, divinyl ether, and 1,4-pentadine in the vapour phase at 22°C were determined by the method previously described.

5521. ABSORPTION OF ACYCLIC OXYGEN COMPOUNDS IN THE VACUUM ULTRAVIOLET. III. ACETONE AND ACETALDEHYDE. J.S.Lake and A.J.Harrison. J. chem. Phys., Vol. 30, No. 2, 361-2 (Feb., 1959).

For Pt I and II see preceding abstracts. The method described was used to determine the 49 000 to 67 000 cm^{-1} absorption spectra of acetone and acetaldehyde in the vapour phase at 22°C.

535.343 : 539.19

5522. ON THE EXPERIMENTAL DETERMINATION OF THE INTENSITY (CRAWFORD'S Γ) OF VIBRATION-ROTATION BANDS. J.Fernández Biarge, J.Herranz and J.Morcillo. An. Real. Soc. Espan. Fis. Quim., Vol. 54(A), No. 9-10, 281-8 (Sept.-Oct., 1958). In Spanish.

Under certain conditions it is possible to determine Γ by measuring the apparent intensity Γ_B utilizing the Wilson-Wells extrapolation except that the observed optical density is integrated with respect to $\log \nu$ rather than ν . The curve giving Γ_B as a function of n/λ has the negative slope

$$\lim_{n \rightarrow 0} \left(\frac{d\Gamma_B}{d(n/\lambda)} \right) = \frac{1}{2} \left[-\frac{1}{6} \left(\frac{d\alpha_\nu}{d(\ln \nu)} \right)^2 a^2 + \frac{1}{80} \left(\frac{d^2 \alpha_\nu}{d(\ln \nu)^2} \right)^2 a^4 + \dots \right] d/\ln \nu$$

where a is the spectral slit width in units of $\ln \nu$, (see Dickson, Mills and Crawford, Abstr. 368/1958).

R.F.Barrow

535.343

5523. PRESSURE-INDUCED INFRARED ABSORPTION OF MIXTURES OF RARE GASES. Z.J.Kiss and H.W.Welsh. Phys. Rev. Letters, Vol. 2, No. 4, 166-8 (Feb. 15, 1959).

A continuous absorption in the region 300-700 cm^{-1} has been observed in compressed He-Ne, He-A, and Ne-A gas mixtures. The absorption at a given frequency is proportional to the product of the partial densities of the component gases, and originates from binary collisions between unlike gas atoms. The effect, which the authors term collision induced translational absorption, is caused by a dipole moment resulting from distortion of the atomic charge distributions.

D.L.Greenaway

535.343

5524. CALCULATION OF LINE WIDTHS IN $\text{H}_2\text{O}-\text{N}_2$ COLLISIONS. W.S.Benedict and L.D.Kaplan. J. chem. Phys., Vol. 30, No. 2, 388-99 (Feb., 1959).

Anderson's general theory of collision line broadening was applied to $\text{H}_2\text{O}-\text{N}_2$ encounters. The only attractive force was assumed to be that between the H_2O dipole, $\mu = 1.87 \times 10^{-18}$ e.s.u. and the N_2 quadrupole, q_{N_2} , an adjustable parameter. A second adjustable parameter, b_m , the distance of closest approach, includes the effects of all other forces. The IBM 704 was used in the calculation. Effects of varying the parameters were noted for a number of lines, and in the final calculation, which yielded the widths of all significant type B transitions up to $J'' = 13$, parameters $q_{\text{N}_2} = 2.62 \times 10^{-29}$ e.s.u. and $b_m = 3.2$ Å which gives an exact fit of the observed width of the microwave line 6₋₅-5₋₁, were adopted. The temperature dependence of the line width over the range 220-2400°K, and the effects of vibration-rotation interactions were also calculated. At 300°K widths vary from 0.11115 $\text{cm}^{-1} \text{atm}^{-1}$ for 1₁-1₋₁ to 0.03200 $\text{cm}^{-1} \text{atm}^{-1}$ for 14₋₁₃-13₋₁₃, there being a general decrease in width with increasing J , and at a given J , decreasing width with increasing τ .

535.343

5525. THE ROTATIONAL SPECTRUM OF OZONE. E.K.Gora. J. molecular Spectrosc., Vol. 3, No. 1, 78-99 (Feb., 1959):

Frequencies and intensities are calculated for the lines which are likely to contribute noticeably either to microwave absorption or to atmospheric absorption in the far infrared. The frequencies of these lines range from 0 to about 2700 000 Mc/s ($\sim 90 \text{ cm}^{-1}$). An estimate of the maximum absorption coefficient of the predicted lines is given for $T = 220^\circ\text{K}$, the average temperature of the atmospheric ozone layer. The results obtained may also prove useful in the analysis of the rotational fine structure of the ozone bands. The values of the molecular constants used in the calculations were determined from the frequencies of ozone microwave absorption lines measured by Hughes and Trambarulo et al.

535.343

5526. LINE INTENSITIES IN VIBRATION-ROTATION BANDS OF DIATOMIC MOLECULES. R.Herman, R.W.Rothery and R.J.Rubin. J. molecular Spectrosc., Vol. 2, No. 4, 369-86 (Aug., 1958).

The expression for the transition probability for a rotating Morse or Pekeris oscillator obtained by Herman and Rubin (Abstr.

4836/1955) has been simplified considerably for numerical calculation. The details of the simplification are presented. In its reduced form, the transition probability consists of the product of the transition probability of a non-rotating Morse oscillator obtained by Heaps and Herzberg (Abstr. 738/1953) and a rotational correction factor which is termed the F-factor. F-factors are calculated for the 1-0, 2-1, 2-0, and 3-0 vibration-rotation bands of HF, HCl, and CO. The F-factors for the fundamental band of a rotating Morse oscillator are shown to be in excellent agreement with the corresponding F-factors for a rotating anharmonic oscillator obtained by Herman and Wallis (Abstr. 5317/1955).

535.343

5527. INFRARED ABSORPTION OF OXYGEN DISCHARGE PRODUCTS AND OZONE AT 4°K. K.B.Harvey and A.M.Bass. J. molecular Spectrosc., Vol. 2, No. 4, 405-10 (Aug., 1958).

The products of a h.f. electric discharge through oxygen were condensed on a cesium iodide plate at approximately 4.2°K. Absorption spectra of the condensates were recorded over the range from 2 to 25 μ . The principal features observed are attributed to ozone and to nitrogen oxides formed from atoms produced in the discharge. The infrared absorption spectrum of ozone at 4.2°K was recorded. From observations of the ozone absorption as function of temperature an upper limit of 3% was inferred for the oxygen atom concentration in the solid.

539.19 : 535.343

MOLECULAR CONSTANTS OF N^{14}O_2 AND N^{15}O_2 . See Abstr. 5528

535.343 : 539.19

5528. INFRARED SPECTRA AND MOLECULAR CONSTANTS OF N^{14}O_2 AND N^{15}O_2 . E.T.Arakawa and A.H.Nielsen. J. molecular Spectrosc., Vol. 2, No. 5, 413-27 (Oct., 1958).

The spectra were observed under high dispersion with gas pressures up to 15 cm of N^{14}O_2 and 4 cm of N^{15}O_2 in a 20 m absorption cell. Ten bands of N^{14}O_2 , eight with well-resolved rotation lines; and nine bands of N^{15}O_2 , seven with well-resolved rotation lines, were observed. The band centres of these bands were determined, from which all the ω_j and x_{ij} were calculated. By making use of the very good assumption that the potential constants are the same for isotopic molecules, the four force constants in the most general quadratic potential function were found to be $f_d = 10.927 \pm 0.065$, $f_\alpha = 1.125 \pm 0.003$, $f_{dd} = 2.038 \pm 0.065$, and $f_{d\alpha} = 0.390 \pm 0.20$ millidynes/Å. The following ground state rotational constants were obtained from the rotational structures of the observed bands using symmetric top combination relations: for N^{14}O_2 , $A = 8.003$, $B = 0.434$, $C = 0.412$; and for N^{15}O_2 , $A = 7.642$, $B = 0.434$, $C = 0.410 \text{ cm}^{-1}$. Theoretical spectra calculated for type A and type B bands by substituting these rotational constants into the asymmetric top equations gave excellent agreement when compared with the observed spectra. The partition function ratio for N^{15}O_2 to N^{14}O_2 is found to be 1.1080 at 25°C.

535.343

5529. INFRARED SPECTRA OF H_2O , D_2O , AND HDO IN SOLID ARGON, KRYPTON, AND XENON. E.Catalano and D.E.Milligan. J. chem. Phys., Vol. 30, No. 1, 45-7 (Jan., 1959).

Infrared spectra of H_2O and D_2O suspended in solid argon, xenon, and krypton were obtained in the temperature range 20-4.2°K. A systematic study of the spectra of these species as a function of concentration and temperature was carried out. Doublets with components centred within a few wave-numbers of the gas phase OH and OD stretching frequencies are observed at dilutions in the range 500-1300 for the quantity M/R (M/R denotes molar ratio of rare gas to H_2O or D_2O). Spectra of these species in the bending region are considerably more complex. Between six and eight bands with frequency separations on the order of 10-20 cm^{-1} are observed in this region. These features appear to be independent of M/R in the range 500-1300. At least one and possibly two of the lower frequency components in the spectrum of H_2O in argon decrease in intensity on lowering the temperature of the sample. These results have been interpreted on the basis that H_2O and D_2O rotate in solid Ar, Xe, and Kr.

535.343

5530. INFRARED SPECTRA OF MONOLAYERS ON METAL MIRRORS. S.A.Francis and A.H.Ellison. J. Opt. Soc. Amer., Vol. 49, No. 2, 131-8 (Feb., 1959).

A double-beam infrared spectrophotometer was modified so that spectra of films as thin as one or a few monolayers in

thickness on metal mirrors can be obtained. It is theoretically predicted and experimentally confirmed that, at the mirror surface, the electric intensity is predominantly perpendicular to the surface. Vibrational modes for which the matrix element of dipole moment is parallel to the surface appear abnormally weak in the spectra. The spectra, therefore, provide information about the orientation as well as the composition of sample films. Spectra of Blodgett films of metal stearates show differences in band positions and band intensities between films one molecular layer in thickness and thicker films. The shifts in band positions are attributed to interactions between carboxylate ions in films thicker than a molecular layer and the absence of such interactions in the first layer. The intensity differences are not explained.

535.343

5531. MATRIX ISOLATION STUDIES. POSSIBLE INFRARED SPECTRA OF ISOMERIC FORMS OF DIAZOMETHANE AND OF METHYLENE, CH_2 . D.E. Milligan and G.C. Pimentel. *J. chem. Phys.*, Vol. 29, No. 6, 1405-12 (Dec., 1958).

The photolysis of diazomethane was studied by the matrix isolation method. Argon and nitrogen matrices were used at 20°K . There is distinct infrared spectral evidence that unstable species have been detected spectroscopically: the production of stable products is inhibited until diffusion is permitted and a red glow accompanies diffusion. Among the identified products produced during diffusion are ethylene, propylene, methane, and polyethylene. The data suggest that methylene is present as well as a tautomeric structure of diazomethane. One of the absorptions observed at 1362 and 1114 cm^{-1} could be the bending mode of CH_2 .

535.343

5532. FREQUENCY SHIFT OF THE ZERO-FIELD HYPERFINE SPLITTING OF Cs^{133} PRODUCED BY VARIOUS BUFFER GASES. M. Arditi and T.R. Carver.

Phys. Rev., Vol. 112, No. 2, 449 (Oct. 15, 1958).

The pressure shift, caused by collisions with various noble gases in the zero-field ground-state hyperfine interaction of Cs^{133} , was measured by an optical transmission, microwave saturation method. A pressure shift to higher frequency was found in the case of the lighter gases, hydrogen, helium, nitrogen, and neon ($+1900$, $+1600$, $+930$, $+650\text{ c/s per mm Hg}$) while a pressure shift to lower frequency was found in the case of the heavier gases, argon, krypton, and xenon (-250 , -1300 , $-2400\text{ c/s per mm Hg}$).

535.343

5533. NARROW HYPERFINE ABSORPTION LINES OF Cs^{133} IN VARIOUS BUFFER GASES. E.C. Beaty, P.L. Bender and A.R. Chi. *Phys. Rev.*, Vol. 112, No. 2, 450-1 (Oct. 15, 1958).

Line widths as narrow as 40 c/s were obtained for the hyperfine transition at 9192 Mc/s in cesium vapour. The Doppler width was greatly reduced by collisions with an inert buffer gas. An optical detection method was used to observe the microwave absorption lines. Shifts in the observed frequency due to collisions with the buffer gas were measured as a function of the temperature and pressure of the gas. It was found possible to reduce greatly the shift in frequency with temperature by using the proper mixtures of inert gases. The contribution to line width due to collisions with the buffer gas was also determined.

535.343 : 537.311.33

5534. ABSORPTION SPECTRA OF GROUP V DONORS IN GERMANIUM. H.Y. Fan and P. Fisher. *J. Phys. Chem. Solids*, Vol. 8, 270-2 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Some recent investigations of infrared absorption associated with lattice imperfections in germanium and silicon are reported. The ionization and excitation bands of group III and group V impurities in germanium were observed at liquid helium temperature and long wavelengths, up to $300\text{ }\mu$. Ionization energies are deduced which are close to the values given by electrical measurements. A number of excitation bands were observed in each case. The spectra of the impurities are compared with one another and with the theoretical calculations of Kohn. The experimental results can be interpreted on the basis of the theory to a certain extent but give extra excitation bands which cannot be explained by the theoretical calculation. The effects of different factors, such as the concentration of impurities, have been studied. Irradiation by high energy neutrons and electrons produces in silicon infrared absorption bands associated with the introduced lattice defects. Several bands have been observed. The possibility of observing a particular absorption band depends on the Fermi level in the irradiated sample which determines the state of

ionization of the defects. The absorption was studied after annealing the sample at different temperatures. It was found that the various absorption bands are associated with different types of defect centre. One of the bands, at $20.5\text{ }\mu$, increased or decreased with temperature annealing, depending on the Fermi level. The observation is understandable on the assumption that the anneal of the type of absorption centre depends upon the state of ionization of the defects.

535.343

5535. FUNDAMENTAL ABSORPTION EDGE IN CADMIUM SULFIDE. D. Dutton.

Phys. Rev., Vol. 112, No. 3, 785-92 (Nov. 1, 1958).

The absorption and reflection spectra of CdS were determined in the temperature range 90 - 340°K by photoelectric measurements on single crystals, using polarized light. The temperature and frequency dependence of the absorption coefficient in the edge, over a substantial range of absorption magnitudes, are well described by expressions of the form

$$\alpha(\nu) = \alpha_0 \exp[-\beta(E_{00} - CT - h\nu)/kT],$$

where the energy ($E_{00} - CT$) is closely associated with the position of an absorption peak. For light polarized, with E vector parallel to the crystalline c-axis, there is one such peak, at $\lambda 4844\text{ Å}$ at 90°K ; for light polarized with E vector perpendicular to the c-axis, the 4844 Å absorption is again present in about equal strength and a stronger line appears at $\lambda 4874\text{ Å}$, shifting the absorption edge toward longer wavelengths by a corresponding amount. These absorption lines, or sharp bands, are observed in the reflectance spectrum, and correspond to absorption lines observed photographically by Gross and others. These results are discussed in the light of the present theoretical picture of absorption in insulating crystals, and it is noted that an exponential absorption edge of this kind, characteristic also of other ionic crystals, cannot be adequately explained in terms of existing models.

535.343

5536. OPTICAL SPECTRUM OF Co^{2+} IN THE CUBIC CRYSTALLINE FIELD OF CaF_2 . R. Stahl-Brada and W. Low. *Phys. Rev.*, Vol. 113, No. 3, 775-80 (Feb. 1, 1959).

The optical spectrum of Co^{2+} in CaF_2 is analysed. Absorption bands are found at $3\text{ }\mu$, $1.5\text{ }\mu$, and $550\text{ m}\mu$. These bands show fine structure. In addition there are weak and narrower bands at 19220 , 19580 , 20450 , 21750 , 22000 and 25750 cm^{-1} , and intense lines at 44250 and 48200 cm^{-1} . The spectrum is interpreted to arise from transitions from the orbital singlet to various Stark levels split by spin-orbit interaction, and yields values of $Dq = 340 \pm 10\text{ cm}^{-1}$, $E(P) = 14000 \pm 100\text{ cm}^{-1}$, and $E(G) = 16250 \pm 100\text{ cm}^{-1}$. The spectrum of Co^{2+} in the eight coordinated cubic symmetry is compared with Co^{2+} in octahedral and tetrahedral symmetry as well as with Cr^{3+} in octahedral symmetry.

535.343

5537. INFRARED ABSORPTION OF REDUCED RUTILE TiO_2 SINGLE CRYSTALS. D.C. Cronmeyer. *Phys. Rev.*, Vol. 113, No. 5, 1222-6 (March 1, 1959).

Rutile TiO_2 single crystal plates have been reduced in hydrogen at about 700°C for several minutes to make them semiconducting. The concentration of oxygen vacancies was controlled by variations of time and temperature. The infrared absorption of a series of plane parallel plates having electrical resistivities ranging from 3 to 0.01 ohm m was examined. It is postulated that the electrical conductivity arises from the ionization of either one or two trapped electrons from each oxygen vacancy. In samples with electrical resistivity ($\perp$ to the c-axis) greater than 0.04 ohm m , the optical absorption at room temperature peaks at about 0.75 eV . For samples with electrical resistivity less than 0.03 ohm m , the optical absorption shows a new maximum at 1.18 eV . The decrease of thermal activation energy with increasing oxygen vacancy concentration is expected to explain the "optical transition" from 0.75 to 1.18 eV . The ionization energies agree reasonably well with those calculated for a helium atom model of a doubly ionizable donor immersed in a dielectric medium [$K_e = n_0^2 = (2.40)^2$], namely 0.73 eV and 1.64 eV . A modification of this theory is also indicated which predicts the second ionization energy as 1.41 eV in better agreement with the experimental value of 1.18 eV .

535.343

5538. THE LOWEST OPTICAL EXCITED STATE OF HEXAMETHYL BENZOL CRYSTALS. H.C. Wolf.

Z. Naturforsch., Vol. 13a, No. 4, 336-45 (April, 1958). In German.

Absorption and fluorescence spectra were obtained at 77°K in polarized light travelling perpendicular to the bc plane. There are

two modifications, one stable and the other metastable below 110°K . Tables and diagrams of line spectra are given. It is thought likely that the only difference between the two structures is due to a switch in position of the CH_3 groups. A.R.Stokes

535.343 : 535.337 : 537.311.33

ZEEMAN-TYPE MAGNETO-OPTICAL STUDIES OF INTER-BAND TRANSITIONS IN SEMICONDUCTORS. See Abstr. 4570

535.343

5539. THE INDIUM DEUTERIDE AND HYDRIDE BANDS AND THEIR HYPERFINE STRUCTURE. H.Neuhaus.

Z. Phys., Vol. 152, No. 4, 402-16 (1958). In German.

Absorption bands of InD are observed in the visible using similar arrangements to that used for InH (see Abstr. 8686/1958). Wave-numbers of the individual lines of the bands are tabulated. The nuclear spin hyperfine structure, where observed, is similar to that for InH. G.F.Lothian

535.343

5540. SPECTRUM AND ZEEMAN EFFECT OF TRIVALENT THULIUM IN THULIUM ETHYL SULPHATE. U.Johnsen.

Z. Phys., Vol. 152, No. 4, 454-69 (1958). In German.

Absorption spectra were measured in the visible at 4.2°K and 80°K for the solid, with and without dilution with isomorphous salts. The Zeeman splitting was also observed. It is possible to assign the transitions of the four observed line groups. G.F.Lothian

G.F.Lothian

535.343 : 535.337

5541. DIAMAGNETIC ZEEMAN EFFECT AND EXCITON STRUCTURE IN THE CRYSTAL OF CUPROUS OXIDE.

E.F.Gross and B.P.Zakharchenya.

Zh. tekhn. Fiz., Vol. 27, No. 9, 1940-3 (1957). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 2, No. 9, 1802-4 (Sept., 1957).

The diamagnetic shift of the yellow series of absorption lines in Cu_2O was studied previously by the authors (Abstrs. 4135, 5985/1957). They now deduce from the experimental results that the magnetic splitting of the lines with $n = 3-6$ in this hydrogen-like series is also purely diamagnetic. The absence of the normal Zeeman effect shows that the lines cannot be due to impurity centres but rather to excitons with equal electron and hole effective masses. D.M.Edwards

D.M.Edwards

535.343

5542. ABSORPTION EDGE SPECTRA IN CADMIUM SULPHIDE CRYSTALS AND THEIR RELATION TO CRYSTAL SURFACE AND DEFORMATION. E.F.Gross and B.S.Razbirin.

Zh. tekhn. Fiz., Vol. 27, No. 9, 2173-6 (1957). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 2, No. 9, 2014-17 (Sept., 1957).

The absorption beyond the fundamental edge was studied. Lines in the range 4860-4800 Å are due to exciton absorption but those in the range 4889-4860 Å vary for different crystal specimens. New absorption bands are observed at 4710 Å and 4660 Å and these are associated with the size of the crystal. The weak bands at 4889-4860 Å seem to be associated with the surface condition of the samples. C.A.Hogarth

C.A.Hogarth

535.343.9 : 535.375.5 : 771.531

NEW SPECIAL PLATES FROM THE FILM FACTORY AGFA WOLFEN FOR RAMAN SPECTROSCOPY. See Abstr. 5290

535.345 : 537.311.33

5543. THEORY OF INFRARED ABSORPTION BY CONDUCTION ELECTRONS IN GERMANIUM. H.J.G.Meyer.

J. Phys. Chem. Solids, Vol. 8, 264-9 (Jan., 1959).

Rochester Semiconductors Conference Paper (Abstr. 4569/1959). It is shown that a theory which takes into account the structure of the conduction band and acoustical, as well as optical intravalley, scattering can be developed without any serious approximation. In combination with an estimate of the possible influence of impurity scattering the theoretical results can be used for the determination of one of the acoustical and of the optical deformation potential constants. From available experimental data, the approximate numerical value of the latter is determined. The general limits of validity of the theory are discussed. 535.345

535.345

5544. OPTICAL TRANSMISSION OF HEAT-TREATED STRONTIUM TITANATE. H.W.Gandy.

Phys. Rev., Vol. 113, No. 3, 795-800 (Feb. 1, 1959).

The room-temperature optical transmission spectra of pure

and doped SrTiO_3 crystals were studied after heating them in oxygen and vacuum; spectral measurements were made in the quantum energy range from 0.1 to 3.4 eV. A blue colour, with strong attendant absorption in the infrared, can be induced in the pure crystals by heating them in vacuum with absorption maxima occurring at 0.9 and 2.9 eV. This induced absorption can be removed by heating the crystals in oxygen. Prolonged heatings of the pure, stoichiometric crystals in oxygen have failed to induce any measurable change in the transmission spectra in the aforementioned energy range. Optical absorption can be induced in iron- and cobalt-doped SrTiO_3 crystal samples by heating them in oxygen; this absorption can be removed by heating the crystals in vacuum. The induced absorption occurs primarily at high quantum energies in the spectra of these doped crystals, with maxima occurring at 2.75 and 2.2 eV in the iron-doped samples, and at 3.0 and 2.6 eV in the cobalt-doped samples. It is suggested that the induced absorption observed in the doped crystals involves a controlled change in the valence states of these impurities. 535.345

535.345

5545. FUNDAMENTAL OPTICAL ABSORPTION IN THE IIA-VIB COMPOUNDS. G.A.Saum and E.B.Hensley.

Phys. Rev., Vol. 113, No. 4, 1019-22 (Feb. 15, 1959).

The fundamental optical absorption in the range of $h\nu$ from 2.5 to 5.8 eV was measured on well-annealed thin films of the following compounds: BaO, SrO, BaS, SrS, CaS, BaSe, SrSe, CaSe, MgSe, BaTe, SrTe, CaTe, and MgTe. The absorption peaks are ascribed to excitons and are observed to shift to lower energies for increasing atomic numbers of either the IIA or VIB elements. A doublet splitting is observed which is close to the values for the spin-orbit splitting of the free negative VIB ions for the selenides and tellurides but which is somewhat larger for the heavier oxides and sulphides. 535.345

535.345 : 539.2

5546. ABSORPTION OF GERMANIUM IN THE NEAR INFRARED AND CRYSTAL DEFECTS. R.Kessler and D.Riccius.

Z. Naturforsch., Vol. 12a, No. 5, 443-5 (1957). In German.

Discusses the origins of free carrier absorption in the near infrared and suggests that crystal perfection and carrier lifetime will affect the agreement between calculated and measured absorption coefficients, usually based only on carrier concentration, mobility, and effective mass. C.A.Hogarth

C.A.Hogarth

535.345

5547. THE BAND ENERGY GAP OF GALLIUM NITRIDE AND ALUMINIUM NITRIDE. E.Kauer and A.Rabenau.

Z. Naturforsch., Vol. 12a, No. 11, 942-3 (1957). In German.

The absorption of the (polycrystalline) samples is determined by measurement of the intensities of reflection against a magnesium oxide layer as standard. The energy gap of GaN was found to be 3.25 eV at room temperature. Measurements made at 90°K and 373°K give a temperature coeff. of -3.9×10^{-4} eV per degree assuming linear variation of ΔE with T . In the spectral region (2-5 eV) investigated no strong absorption by AlN was found. W.Good

W.Good

535.345

5548. INFRARED ABSORPTION OF N-TYPE INDIUM ARSENIDE. F.Matossi.

Z. Naturforsch., Vol. 13a, No. 9, 767-70 (Sept., 1958). In German.

The edge absorption of n-type InAs containing a net impurity density of 10^{16} cm^{-3} was measured between 120 and 475°K . The absorption coefficient is described by two exponential functions of the frequency, (of the form $\exp[h(\nu - \nu_0)/kT]$ where T is an effective temperature of either 75°K or 1800°K). The results are discussed in terms of Dexter's hypothesis about the edge potentials in the ground and excited states as a function of configuration coordinates. C.A.Hogarth

C.A.Hogarth

535.345

5549. ON THE INFRARED ABSORPTION OF GALLIUM TELLURIDE (Ga_2Te_3) AND INDIUM TELLURIDE (In_2Te_3). G.Harbecke and G.Lautz.

Z. Naturforsch., Vol. 13a, No. 9, 775-9 (Sept., 1958). In German.

Measurements near the absorption edge in the temperature range 20°K to 650°K are reported. Evidence for indirect transitions is obtained. Discrepancies in the activation energies obtained by extrapolating the optical values linearly back to $T \rightarrow 0^\circ\text{K}$ and from electrical measurements are discussed. C.A.Hogarth

C.A.Hogarth

535.345

5550. ULTRAVIOLET TRANSMISSION PROPERTIES OF CONDUCTING COATINGS ON GLASS. D.W.Juenker and E.W.Parsons. J. Opt. Soc. Amer., Vol. 48, No. 11, 857 (Nov., 1958).

Coatings of Sn, prepared after the method of Gomer (Rev. sci.

Instrum., Vol. 24, No. 10, 993, Oct., 1953) show transmissions decreasing towards $\lambda = 2500$ Å. Uses a cut-off filter and a partly transparent collector for a photocell. G.F.Lothian

535.345

5551. CALORIMETRIC METHOD OF MEASURING THE ABSORPTION COEFFICIENT OF WATER. Yu.V.Mal'tsev. Zh. tekhn. Fiz., Vol. 28, No. 9, 2084-91 (1958). In Russian.

Describes the apparatus, method and possibilities of use. A focal monochromator emits radiation as a divergent beam limited by two coaxial conical surfaces; this beam is directed on the water surface in a conical flask and, since the uppermost layer absorbs more light than the lowest layer, the former is heated to a higher temperature than the latter. The temperature difference is measured by means of a thermopile with photo-compensation, amplifier and recorder. An amplitude method is used for the purpose of reducing the error caused by the shift of the nullpoint of the apparatus. The working model of the apparatus enables the absorption coefficient of water $> 0.5 \text{ m}^{-1}$ to be measured in individual spectral regions with a relative error $< 10\%$. F.Lachman

535.345

5552. SCATTERING AND ABSORPTION OF ELECTROMAGNETIC RADIATION BY INFINITE CYLINDERS. B.K.Larkin and S.W.Churchill.

J. Opt. Soc. Amer., Vol. 49, No. 2, 188-90 (Feb., 1959).

Expressions suitable for machine computation are presented for the scattering and absorbing properties of infinitely long, dielectric, and conducting cylinders. These properties include the amplitude functions, the angular distribution of scattered light, and the scattering and absorbing cross-sections for both parallel and perpendicular polarized light. Illustrative calculations were carried out for real indices of refraction of 1.5, 2.0, and 2.5 at circumference to wavelength ratios of 0.5, 1.0, 1.5, 2.0, 3.0, and 4.0.

535.345 : 519.2

5553. RADIATIVE TRANSPORT FROM POINT SOURCES IN A STRATIFIED MEDIUM. P.I.Richards.

J. Opt. Soc. Amer., Vol. 49, No. 3, 245-9 (March, 1959).

The Spencer-Fano method of moments is extended to make possible numerical computation of the transport of radiation from point or line sources in media whose macroscopic cross-sections depend on one Cartesian coordinate. Convergence is satisfactory if the scattering angular distribution is a low-order polynomial in $\cos \theta$. Sample calculations of the scalar flux and total upward current per unit area are presented for a point source at the centre of a plane-parallel slab, two mean free paths thick.

535.345.6

5554. ANALYSIS OF THE OPTICAL BEHAVIOUR OF LIPPMANN-TYPE FILTERS. D.Canals-Frau.

Optica Acta, Vol. 4, No. 4, 121-4 (Dec., 1957). In French.

The basic idea of this method is to consider the "activated layer" (which corresponds to the anti-nodes of the stationary wave formed by the filter) as consisting of a dielectric medium (gelatine) containing a random distribution of grains of metallic silver. If these grains are small compared with wavelength and their concentration low, this layer can be considered as an artificial dielectric. Under these conditions the refractive index of the layer is invariant (to a certain order of approximation), while the "reflection factor" (admittance) does vary (to the same order of approximation).

535.37

5555. MEASUREMENT OF FAST LUMINESCENCE DECAY TIMES. H.Dreeskamp and M.Burton.

Phys. Rev. Letters, Vol. 2, No. 2, 45-6 (Jan. 15, 1959).

A scintillator is excited by an X-ray beam triggered by a pulse to the tube grid. The light falls on the photo-cathode of an image converter and photoelectrons are accelerated by 5-15 kV to the luminescent screen, passing between deflecting plates so biased that normally the light from the screen does not reach the photomultiplier detector. A second pulse from the generator operates a voltage sweep on the deflector plates, and for a period calculated as $0.5 \mu\text{sec}$ the photomultiplier receives the output light. This period can be delayed with respect to the initial excitation by cables of varied lengths to provide a number of points on the rise and decay curves. Means of integrating weak signals and of overcoming noise and slow response of the photomultiplier—oscilloscope circuits are incorporated. The limiting factor in time resolution is the rise and cut-off time of the X-ray beam ($1.2 \mu\text{sec}$). S.T.Henderson

535.37 : 539.2
5556. ON THE STRUCTURE OF LUMINESCENCE CENTRES IN COPPER ACTIVATED ZINC SULPHIDE PHOSPHORS. W.Reichardt and G.Tappe.

Z. Naturforsch., Vol. 13a, No. 1, 57-8 (Jan., 1958). In German.

Radiation damage by alpha-particles in ZnS-CuCl phosphors gives rise to changes in the thermoluminescence characteristics peaks appearing in the curve at -135, -100, -150 and 35°C instead of the single original peak at -100°C for the undamaged phosphor. The maxima agree with those for ZnS-ZnO-CuCl phosphors and it is concluded that such irradiation produces sulphur vacancies in the lattice. The note further discusses the nature of the "blue" and "green" emission centres in such phosphors. G.F.J.Garlick

535.37 : 537.533

INVESTIGATIONS OF THE EXO-ELECTRON EMISSION AND LUMINESCENCE OF INORGANIC CRYSTALS. See Abstr. 4688

535.371

5557. CORRECTIONS AND ADDITIONAL REMARKS TO THE PAPER: SELF-DEPOLARIZATION AND DECAY OF PHOTOLUMINESCENCE OF SOLUTIONS, ACTA PHYS. POLON. 14, 295 (1955). A.Jabłoński.

Acta phys. Polon., Vol. 17, No. 6, 481-2 (1958).

See Abstr. 6530 (1956).

535.371

5558. ASSOCIATED DONOR-ACCEPTOR LUMINESCENT CENTERS IN ZINC SULFIDE PHOSPHORS. E.F.Apple and F.E.Williams.

J. Electrochem. Soc., Vol. 106, No. 3, 224-30 (March, 1959).

Zinc sulphide activated with copper or silver and coactivated with gallium or indium shows two emission bands. The shorter wavelength band does not involve the ground state of the coactivator or donor, whereas the longer wavelength band does. Both bands involve the ground state of the activator or acceptor. The factors contributing to the emission intensities from the various associated donor-acceptor pairs are discussed theoretically. The dependences on temperature and on concentrations of activator and coactivator are in accord with the longer wavelength band involving a highly associated donor-acceptor pair. In addition, the energy levels of the donors, as obtained from thermoluminescent data, are correlated on the basis of the model with the differences in the transition energies of the two emission bands of these phosphors.

535.371 : 537.312.5

5559. INFRARED PHOSPHOR-SEMICONDUCTORS. G.F.J.Garlick.

J. Phys. Chem. Solids, Vol. 8, 449-57 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). A review of progress over the past few years is given, with special reference to the emission of zinc and cadmium sulphide phosphors, lead sulphide, lead telluride and mercury sulphide. The infrared emission found in zinc sulphide is ascribed to electron transitions from the valence band to the ground states of visible emission centres. In mercury sulphide the characteristics of the excitation and emission spectra suggest a different mechanism. This also applies to lead sulphide and lead telluride. New results on cadmium telluride, made p- or n-type under controlled conditions, show a number of emission bands extending to 2.6μ . Excitation and photovoltage excitation curves coincide with emission bands, there being no Franck-Condon shift. The results are given a tentative theoretical explanation.

535.371

5560. PHOSPHOR WITH FLUORESCENCE LARGER THAN THE ENERGY GAP. S.P.Keller and G.D.Pettit.

Phys. Rev., Vol. 113, No. 3, 785-6 (Feb. 1, 1959).

Under certain conditions of excitation a Pr^{+3} -activated SrS phosphor exhibits an emission which is energetically greater than the energy gap. This emission is observed at 77°K and not at room temperature. It is proposed that the excitation and short-wavelength emission take place between levels of the Pr^{+3} centre. At 77°K the reduction of lattice vibrations effects the isolation of the Pr^{+3} site from the lattice and hence the probability of hole transfer from the activator to the lattice is diminished. The nature of the energy levels of the Pr ion is discussed.

535.371

5561. SOME PROPERTIES OF GREEN AND RED-GREEN LUMINESCING CdS. Y.T.Sihvonen, D.R.Boyd and C.D.Woelke. Phys. Rev., Vol. 113, No. 4, 965-8 (Feb. 15, 1959).

A series of electro-optical experiments at room temperature

were made with two types of high-purity single crystals of CdS. Those of type A, believed to have near-perfect stoichiometry, luminesce green (5145 Å) under 3650 Å ultraviolet irradiation, have low dark conductivity (2.5×10^{-11} mho cm^{-1} at 300°K), exhibit no photo-peak, and have a relatively short carrier lifetime (about 4 micro-seconds or less). Those of type B, believed to have a sulphur deficiency, luminesce first strongly red (≈ 7200 Å), then strongly green (> 5145 Å) as the exciting radiation is increased in intensity. Simultaneously both emissions shift toward longer wavelengths. Also, as the red emission intensity begins to saturate, the intensity-rate change of conductivity abruptly changes. It is suggested that red luminescence is the result of a free hole capture by one of the electrons residing in a sulphur vacancy. This trapping sensitizes the crystal but at the expense of increasing carrier lifetime to milli-second magnitudes. Furthermore, some of these vacancies (~ 0.4 eV below the conduction band) act as donors to increase dark conductivity (about 10^{-9} mho cm^{-1} at 300°K).

535.371

5562. EXCITATION SPECTRA AND TEMPERATURE DEPENDENCE OF THE LUMINESCENCE OF ZnS SINGLE CRYSTALS. A. Halperin and H. Arbell.

Phys. Rev., Vol. 113, No. 5, 1216-21 (March 1, 1959).

The luminescence of ZnS:Cl and ZnS:Cu:Cl crystals was measured for the temperature region 80-500°K and for different wavelengths of exciting light. The behaviour of the luminescence v. temperature curves differed from similar curves for powders reported in literature. Excitation spectra were also obtained for the green and blue luminescence bands. These were found to consist of a complexity of fine bands. Each of the bands was found not to shift when varying the temperature of the crystal. The relative intensity of the bands near the absorption edge of the crystal, however, changed with temperature in such a way as to cause an apparent shift in the maximum of the excitation spectrum in this region.

535.371

5563. POLARIZATION OF FLUORESCENCE IN ZnS AND CdS SINGLE CRYSTALS. A. Lempicki.

Phys. Rev. Letters, Vol. 2, No. 4, 155-7 (Feb. 15, 1959).

The polarization was measured of impurity fluorescence of ZnS:Cu or Mn and CdS crystals, excited with natural or plane polarized 3650 Å radiation. The fluorescence is polarized preferentially perpendicular to the c axis. The degree of polarization depends on the crystal structure, perfection and impurity activation. Simple dipole theories cannot account for the observations (see abstract following).

J. Franks

535.371

5564. POLARIZATION OF FLUORESCENCE IN CdS AND ZnS SINGLE CRYSTALS. J. L. Birman.

Phys. Rev. Letters, Vol. 2, No. 4, 157-9 (Feb. 15, 1959).

The polarization of fluorescence in CdS and ZnS (see preceding abstract) is explained using the Lambe-Klick model (Abstr. 6035/1955). Consideration of energy levels of the wurtzite structure for CdS indicate that the polarization of the 6200 Å emission should obey the same law as that of the edge emission. The ZnS case is more complex because of crystal disorder and zinc blende-wurtzite mixtures.

J. Franks

535.371

5565. ON THE DEPOLARIZING EFFECT OF SECONDARY FLUORESCENCE. A. Budó and I. Ketskemeti.

Z. Naturforsch., Vol. 12a, No. 8, 673-4 (1957). In German.

Reabsorption and subsequent re-emission of fluorescence polarization is examined experimentally and compared with theoretical formulae.

G. F. J. Garlick

535.371

5566. ENERGY TRANSPORT IN THE FLUORESCENCE OF ORGANIC SOLUTIONS. H. Knau.

Z. Naturforsch., Vol. 12a, No. 11, 881-6 (1957). In German.

Very short decay times of organic fluorescent materials are measured by a phase comparison method. A study of the decay time of anthracene and tetracene in different solutions and dependence on concentration provides information on the energy transport properties. For large concentrations a direct radiationless transfer from solute to solvent occurs. For low concentrations excited solvent molecules migrate randomly until a solute molecule is encountered.

G. F. J. Garlick

535.371 : 537.312.5

PHOTOCONDUCTION IN PHOSPHORS. See Abstr. 4603

535.372

5567. THE ANGULAR DISTRIBUTION OF INTENSITY AND POLARIZATION RATIO OF THE FLUORESCENCE OF ANTHRACENE CRYSTALS. F. R. Lipsett and L. Tardif.

Canad. J. Phys., Vol. 36, No. 10, 1438-41 (Oct., 1958).

Experiments are described for the measurement of angular intensity distribution, which agrees with the assumption of a diffusely fluorescent substance. As regards polarization ratio, (defined as the ratio of maximum to minimum intensity for linearly polarized fluorescence) this shows a variation for crystals grown under different conditions, and this ratio is highest for crystals with the best surfaces. All results apply to the total fluorescence.

F. Ansbacher

535.372

5568. LOW-TEMPERATURE FLUORESCENCE SPECTRA AND CRYSTAL FIELD SPLITTINGS OF RARE-EARTH ACTIVATED SrS PHOSPHORS. S. P. Keller and G. D. Pettit.

J. chem. Phys., Vol. 30, No. 2, 434-41 (Feb., 1959).

As a continuation of earlier work (see Abstr. 1314/1959), SrS phosphors, singly activated with rare-earth ions, were excited with u.v. irradiation at 77°K. The resultant visible fluorescent emissions were measured and correlated with crystal field splittings of energy levels. Energy level diagrams are presented with possible term assignments. Where possible, comments are made about the symmetry of the activator sites.

535.372

5569. SPECTROSCOPICALLY DETECTABLE ELECTRON STATES OF STABLE AND METASTABLE MOLECULAR FORMS OF SOME ACRIDINE DYESTUFFS AND FLUORESCEN CATIONS.

V. Zanker and E. Miethe.

Z. Naturforsch., Vol. 12a, No. 5, 385-95 (May, 1957). In German.

Optical excitation of certain molecules yields metastable triplet electron levels which decay by phosphorescence to the ground state (singlet level) with a period of some seconds. The absorption spectra arising from excitation of the electrons of both states are measured for 3,6-diaminoacridine, 9-phenyl-3,6-diaminoacridine, 3,6-bisdimethylaminoacridine and fluorescein; results are given as curves and tables of excitation levels covering the range 9000-50 000 cm^{-1} . Specimens are diluted (10^{-4} M) in an ether-alcohol mixture and cooled to -183°C . It is concluded that the coupled triplet electrons are not localized.

G. F. Lothian

535.372

5570. ON THE INFLUENCE OF CRYSTAL TYPE ON THE LUMINESCENCE OF $\text{NH}_4\text{Br-TlBr}$. P. Brauer.

Z. Naturforsch., Vol. 13a, No. 11, 1002-3 (Nov., 1958). In German.

Relative and absolute intensities of the violet and green emission bands are affected by the type of lattice (NaCl or CsCl). Studies of intensity dependence on temperature and hysteresis effects occurring during warming between 100° and 150°C suggest that the violet emission is due to single Tl^+ ions but the green emission may be due to aggregate Tl centres.

G. F. J. Garlick

535.373

5571. VARIATION OF VALENCE STATE OF Eu IN SrS PHOSPHORS. S. P. Keller.

J. chem. Phys., Vol. 30, No. 2, 556-60 (Feb., 1959).

Phosphors containing SrS as the base material and 0.04% Eu as the activator were prepared in various reducing or oxidizing atmospheres. Firings in reducing atmospheres produced divalent Eu and firings in oxidizing atmospheres produced decreasing amounts of divalent Eu and increasing amounts of trivalent Eu depending on the degree of oxidizing character of the atmosphere. The relative amounts of the two valence states were determined by observing the fluorescent emission and by measuring the paramagnetic resonance absorption of the samples.

535.376

5572. RELATIVE PULSE HEIGHT OF PROTONS AND ELECTRONS IN KI(Tl). P. Kienle and R. E. Segel.

Phys. Rev., Vol. 113, No. 3, 909-11 (Feb. 1, 1959).

The relative scintillation efficiency for protons and electrons in KI(Tl) was measured in the energy range of a few MeV. Protons were found to give a greater light output than electrons, and a pulse-height ratio $p : e = 1.42 : 1$ was determined.

5573. FURTHER DEVELOPMENT OF EXPERIMENTAL LAYOUT FOR EMISSION SPECTROSCOPY OF ORGANIC SUBSTANCES IN THE POSITIVE COLUMN OF A GLOWING DISCHARGE. OBSERVATIONS WITH CHLOROBENZENE (C_6H_5Cl). H. Schüler and E. Lutz. Z. Naturforsch., Vol. 12a, No. 4, 334-7 (1957). In German.
Further development of a method described in a previous paper (Schüler, Spectrochimica Acta, Vol. 4, 85, 1950), and based on the observation of the luminescence of organic substances. It is shown that the maintenance of constant current intensity, carrier-gas pressure, pressure of the tested substance at the spot of vaporization, and temperature of the discharge tube guarantee the reproducibility of spectra. It is possible to obtain isolated spectra, because in suitable conditions other luminescences are considerably suppressed. A weak band spectrum was found for the "final stage" of C_6H_5Cl , and a new, seemingly continuous spectrum was observed between 3400 and 4400 Å. F. Lachman 535.376
5574. THE MECHANISM OF REACTION OF ORGANIC MOLECULES IN THE POSITIVE COLUMN OF A GLOW DISCHARGE. H. Schüler and M. Stockburger. Z. Naturforsch., Vol. 12a, No. 6, 507-13 (1957). In German.
Intensities of spectra obtained in the glow discharge of C_6H_6 , $C_6H_5CH_3$, C_6H_5Cl and $C_6H_5CH_2C_6H_5$ were measured at different values of discharge current; two different types of intensity/current curves were obtained, the first of which corresponds with the excitation of the original molecule by electron impact, while the second corresponds with excitation by "transport energy", i.e., energy emitted without radiation by a part of the excited molecules. It appears that the collision between the excited and non-excited initial molecules plays an important part in the phenomenon of luminescence of organic molecules in a glow discharge. This kind of energy transfer has been also confirmed in the case of He. F. Lachman 535.376
- THE DIFFERENTIAL EXCITATION POWER OF α -PARTICLES IN LUMINESCENT PLASTIC FOILS. See Abstr. 4758 535.376 : 537.572
- INELASTIC NUCLEAR REACTIONS OF PROTONS IN SCINTILLATORS. See Abstr. 5038 535.376 : 539.1.07 : 539.17
5575. A.C.-D.C. ELECTROLUMINESCENCE. W.A. Thornton. Phys. Rev., Vol. 113, No. 5, 1187-91 (March 1, 1959).
The enhancement of electroluminescence, by the superposition of a.c. and d.c. voltages, was observed in certain electroluminescent zinc sulphide powder phosphors. The addition of a d.c. voltage to an a.c. voltage exciting visible electroluminescence increases the emission as much as 250 times, under conditions where the d.c. electroluminescence alone is about equal to the initial a.c. electroluminescence. Wave form, transient, and spectral measurements show that the increased emission is recombination, at d.c.-ionized luminescence centres, forced by the a.c. field. 535.376
5576. ELECTROLUMINESCENCE IN CUPROUS OXIDE. R. Frerichs and R. Handy. Phys. Rev., Vol. 113, No. 5, 1191-8 (March 1, 1959).
This paper reports the observation of electroluminescence in cuprous oxide. The variations in electroluminescent light output were studied as a function of excitation frequency, wave shape, voltage, current, and power as well as for changes in ambient temperature. These basic properties are presented in graphic form and show that Cu_2O does not fit readily into either of the two general classes of electroluminescent materials, but possesses new and unusual properties of its own. The electroluminescence can be observed in cuprous oxide plate rectifiers and in point contact structures. In the plate rectifiers, changes in electrical properties known as current creep occur during excitation which are reflected in the light emission from the plates. This effect was studied in detail and a new theoretical model proposed that satisfactorily accounts for the observed changes in the electrical properties, as well as for the published observations on commercial Cu_2O rectifiers. Unusual memory properties were observed that permit the initial electroluminescent light output to be enhanced by prebiasing with direct currents. This phenomenon is traced to the movement of matter within the material during the biasing interval. 535.39 : 535.434
5577. ON THE NATURE OF "DRUMMOND'S LIGHT". A.N. Gorban' and V.A. Sokolov. Optika i Spektrosk., Vol. 5, No. 6, 713 (1958). In Russian.
"Drummond's light" is the very bright emission by CaO when excited by flames. The authors found that below 600-650°C the action of flames on CaO produces luminescence ("cathodoluminescence") whose spectrum is identical with that of cathodoluminescence. Above 600-650°C normal thermal radiation was observed. A. Tybulewicz 535.377
5578. EFFECT OF THERMAL PRETREATMENT ON THE THERMOLUMINESCENCE OF KCl CRYSTALS. A. Halperin and M. Schlesinger. Phys. Rev., Vol. 113, No. 3, 762-6 (Feb. 1, 1959).
Thermal pretreatment was found to enhance the thermoluminescence of X-coloured KCl crystals. The effect was found to penetrate into the crystal by diffusion from the outer surfaces. It is affected by the atmosphere surrounding the heated crystal, and it seems also to be structure sensitive. For some crystals the enhancement in the thermoluminescence was by a factor as high as 4000 when the number of quanta emitted during the thermoluminescence was about the same as the number of F electrons bleached during this process. 535.379
5579. MEASUREMENTS OF SONOLUMINESCENCE FROM PURE LIQUIDS AND SOME AQUEOUS SOLUTIONS. P. Jarman. Proc. Phys. Soc., Vol. 73, Pt 4, 628-40 (April, 1959).
An exhaustive study of sonoluminescence was made at a frequency of 16.5 kc/s. The temperature dependence of the luminescence from 15 pure liquids and some aqueous solutions was determined in the range 4° to 80°C. The intensity of luminescence was correlated with various parameters; the best correlation was found with (surface tension)/(vapour pressure). Photographs were taken showing that sonoluminescence generally occurred as a single discrete flash once every sound cycle. This flash appeared to occur within a tenth of a period from the sound pressure minimum with non-volatile liquids like water; with volatile liquids, the flash apparently occurred shortly before or at the sound pressure maximum. Sometimes a secondary flash occurred shortly before or after the main flash. No sonoluminescence was detected from any liquid when the cavitation bubbles collapsed, i.e. shortly after the sound pressure was a maximum. The results would appear to substantiate the theories that sonoluminescence is caused by electrical microdischarges occurring within the cavitation bubbles and by the photochemical recombination of dissociated molecules at the nascent surfaces of these bubbles. 535.39
5580. THE OPTICAL CONSTANTS n AND k OF LiF IN THE REGION OF THE INFRA-RED RESIDUAL-RAY BANDS. G. Heilmann. Z. Naturforsch., Vol. 13a, No. 3, 238 (March, 1958). In German.
The results shown graphically cover the range 15-36 μ and 20-600°C. The optical arrangement used is stated to have been essentially that of Neuroth (Abstr. 2807/1956) with a KBr prism for 15-23 μ and a KRS5 prism for 23-36 μ . S. Weintraub 535.39 : 535.434
5581. CONTRIBUTION TO THE INTERPRETATION OF ANOMALOUS OPTICAL PROPERTIES OF HIGHLY CONCENTRATED METALLIC COLLOIDS OF SMALL PARTICLE SIZE. I. DETERMINATION OF THE SPACE-FACTOR OF THIN FILMS OF A GOLD-SiO₂ COLLOID. W. Hampe. Z. Phys., Vol. 152, No. 4, 470-5 (1958). In German.
The ratio (gravimetric)/(interferometric) thickness was determined directly for colloidal gold suspended in SiO₂ with an accuracy of 15%. R.A. Weale 535.39 : 535.434
5582. CONTRIBUTION TO THE INTERPRETATION OF THE ANOMALOUS OPTICAL PROPERTIES OF HIGHLY CONCENTRATED METALLIC COLLOIDS OF SMALL PARTICLE SIZE. II. EXPERIMENTAL INVESTIGATION OF THE ABSORPTION CURVE AND INTERPRETATION OF THE ABSORPTION MECHANISM OF THE SYSTEM GOLD-SiO₂. W. Hampe. Z. Phys., Vol. 152, No. 4, 476-94 (1958). In German.
A comparison between theory and experiments done on Au-SiO₂ colloidal films shows that, in the visible part of the spectrum, the imaginary part of the dielectric constant is expressible in terms of plasma resonance of the conducting electrons in the individual

colloid particles. Damping is said to be due to the reduced mean free path. R.A.Weale

535,393

5583. A GENERAL SOLUTION OF THE THIN FILM PROBLEM IN OPTICS. A.Bigelmaier.

Optica Acta, Vol. 4, No. 3, 81-6 (Sept., 1957). In German.

Explicit formulae are given for the transmission and reflection of a system of plane parallel thin films. Coupling effects arising in various possible arrangements are described by coupling factors.

535,399

5584. OPTICAL CONSTANTS OF GERMANIUM IN THE REGION 1 TO 10 eV. H.R.Philipp and E.A.Taft.

Phys. Rev., Vol. 113, No. 4, 1002-5 (Feb. 15, 1959).

The reflectance, $|r(\lambda)|^2$, of single-crystal germanium was measured in the range 0.6 to 11.3 eV. The phase, $\theta(\lambda)$, was computed from these data using the Kramers-Kronig relation between the real and imaginary parts of the complex function $\ln r = \ln |r| + i\theta$. The optical constants, n and k , were then determined from the Fresnel reflectivity equation. The real part of the refractive index, n , has maxima of 5.5 at 2.07 eV and 4.2 at 3.2 eV. Above 6 eV, the index is very nearly 1. The extinction coefficient, k , shows maxima of 2.0 at 2.5 eV and 4.2 at 4.4 eV. Below 3.5 eV, the results are in good agreement with the recent measurements of Archer (Abstr. 8710/1958). Beyond this point, they depart from his extrapolated curve.

535,411

5585. PROPERTIES OF ALL-DIELECTRIC INTERFERENCE FILTERS. I. A NEW METHOD OF CALCULATION. P.H.Lissberger.

J. Opt. Soc. Amer., Vol. 49, No. 2, 121-5 (Feb., 1959).

The reflection coefficient of a system of perfect quarter-wave layers is obtained in terms of the Fresnel coefficients of various boundaries by a simple summation process. This result is used to calculate the phase change on reflection from a system of approximate quarter-wave layers and this is shown to depend linearly on the phase errors of the individual layers. From the resulting formulae the important features of the transmission characteristics of all-dielectric interference filters are evaluated.

535,411

5586. PROPERTIES OF ALL-DIELECTRIC INTERFERENCE FILTERS. II. FILTERS IN PARALLEL BEAMS OF LIGHT INCIDENT OBLIQUELY AND IN CONVERGENT BEAMS. P.H.Lissberger and W.L.Wilcock.

J. Opt. Soc. Amer., Vol. 49, No. 2, 126-30 (Feb., 1959).

The basic formulae derived in Pt I (see preceding abstract) are used to determine the wavelength of the transmission band when all-dielectric interference filters are used in parallel beams incident obliquely. Experimental results agree well with the theoretical predictions provided that the dispersion of the layers is taken into account. The transmission characteristics of filters in convergent beams are evaluated on the basis of the expressions for oblique incidence.

535,412

5587. THE EFFECTS OF COLLIMATION AND OBLIQUE INCIDENCE ON THE VISIBILITY OF INTERFERENCE FRINGES. B.S.Thornton.

Optica Acta, Vol. 4, No. 4, 147-50 (Dec., 1957).

The visibility of two-beam interference fringes is of interest in the measurement of long lengths, as well as being one of the earliest means of analysing the fine structure of spectral lines. The aim of this paper is to investigate how the size of the aperture through which the light enters the interferometer affects the visibility of the fringes, in the case of a narrow slit and a circular aperture.

535,417 : 531,715

5588. PARALLEL TESTING INTERFEROMETER. J.B.Saunders. J. Res. Nat. Bur. Stand., Vol. 61, No. 6, 491-8 (Dec., 1958).

Describes an interferometer for measuring the parallelism of gauge blocks and other bodies of any reasonable length without the necessity of the wringing operation. Two forms of this instrument are used — one for testing long blocks and another for testing short blocks. Either form can be constructed for testing blocks of any length, but two forms are found to be more practical.

535,417

5589. OBLIQUITY EFFECTS IN INTERFEROMETRY. C.F.Bruce. Optica Acta, Vol. 4, No. 4, 127-35 (Dec., 1957).

The present author (Abstr. 8655/1955) and Thornton (Abstr. 8656/1955) have previously described the influence of oblique rays

on the measurement of length by interferometry. On-centre apertures were treated with adequate exactness but off-centre apertures were treated approximately. This paper deals with a more exact treatment of the off-centre cases for circular and rectangular apertures. The treatment is adequate for all cases that may occur in practice and the expressions for on-centre cases are quickly derivable. The results show that approximate formulae can give quite incorrect results at path difference and obliquity values which still allow fringes to be observed when isotope light sources are used. Fringe displacement curves are given to show the main characteristics of the obliquity effects, and these have been confirmed experimentally.

535,417 : 531,715

5590. SOME METHODS FOR MEASUREMENTS ON THIN FILMS. A.C.S. van Heel and A.Walther.

Optica Acta, Vol. 5, 1-2, 47-52 (March-June, 1958).

Four modifications of Francon's interference eyepiece are given which enable one to measure the step in a wave-front and at the same time the light-loss. As it is possible to carry out measurements while depositing the layer, the methods described can be used for monitoring purposes, the non-optical windows not doing much harm to the appearance of the field of view. With the available apparatus a precision in the determination of the light path of $\lambda/200$ is easily obtainable for all layer thicknesses.

535,417

5591. AN INTERFEROMETER WITH A CONCAVE DIFFRACTION GRATING. F.M.Gerasimov and S.S.Naumov.

Optika i Spektrosk., Vol. 5, No. 6, 682-5 (1958). In Russian.

Light beams diffracted by a grating may interfere with one another provided they are coherent. The authors used this fact to construct an interferometer with a concave grating. The optical system of this interferometer included two plane mirrors, which were used to reverse the first-order diffracted beams along their original paths. The diffracted and the incident waves interfered with one another to produce a system of fringes, provided the incident beam was monochromatic. The interferometer was used successfully in testing of reflecting surfaces and plane diffraction gratings. A.Tybulewicz

535,417 : 531,715.1

5592. DEVELOPMENTS IN THE COMPARISON OF LENGTHS USING FRINGES OF SUPERPOSITION IN WHITE LIGHT. A.H.Cook and H.M.Richardson.

Proc. Phys. Soc., Vol. 73, Pt 4, 661-70 (April, 1959).

When two Fabry-Perot etalons are placed one in front of the other, and the length of one is a small multiple of that of the other, fringes are seen in white light and have been used in the past to compare the lengths of etalons. In the study reported in this paper, these fringes have been observed photoelectrically while the optical length of one etalon is varied by changing the pressure of the air inside it. It is shown that the variation of intensity with path difference is the sum of two Fourier integrals involving an intensity function and the phase shifts at the reflecting surfaces. By forming cosine and sine Fourier transforms these quantities can be obtained separately and a correction applied for the error introduced into the comparison of lengths by the change of the phase shifts with wavelengths. It is shown that phase shifts can be measured more accurately by this method than by other interferometric means. It is possible to compare a metre length with a 20 cm length to about 1×10^{-8} .

535,42 : 534,321.9

5593. THE EFFECT OF A PROGRESSIVE ULTRASONIC WAVE ON A LIGHT BEAM OF FINITE WIDTH. K.L.Zankel. Naturwissenschaften, Vol. 46, No. 3, 105-6 (1959).

The light beam enters the wave at right angles to the direction of propagation. An expression is given, but not derived, for the diffracted intensity as a function of time and angle of diffraction. W.T.Welford

535,42 : 534,26

EFFECT OF FLUCTUATIONS IN THE INCIDENT WAVE ON THE DISTRIBUTION OF MEAN INTENSITY NEAR THE FOCUS OF A LENS. See Abstr. 5466

535,43 : 538,566.2 : 530,19

PENETRATION OF RADIATION IN NATURAL SCATTERING MEDIA. See Abstr. 5388

535.434 : 551.521.3
5594. EXPERIMENTAL DISCOVERY OF ELLIPTICITY OF POLARIZATION OF SCATTERED LIGHT. G.V.Rozenberg and I.M.Mikhailin. Dokl. Akad. Nauk SSSR, Vol. 122, No. 1, 62-4 (1958). Also in: Optika i Spektrosk., Vol. 5, No. 6, 671-81 (1958). In Russian.

Reports the degree of polarized-light ellipticity due to scattering by atmospheric aerosols. A powerful (11.5 kW) projector and a polarizer were used to produce a strong beam of light. The beam was parallel to the ground surface and at a height of 2 m. Measurements were made at night in a valley in Northern Caucasus. A theodolite was fitted with a polaroid and a filter in front of the ocular, and with a quarter-wave plate and a Wollaston prism in front of the objective, and used as a polarimeter. This polarimeter was placed at a distance of 2 m from the light beam and q, the degree of ellipticity of polarization of light scattered in air, was measured at various scattering angles θ . The value of q was found to be of the order of 0.1 and $q(\theta)$ could be represented roughly as $q = k \cos 3\theta$.

A.Tybulewicz
535.434

5595. THEORETICAL INVESTIGATIONS ON THE LIGHT SCATTERING OF COLLOIDAL SPHERES. V. FORWARD SCATTERING. W.Heller, M.Nakagaki and M.L.Wallach. J. chem. Phys., Vol. 30, No. 2, 444-50 (Feb., 1959). For Pt IV, see Abstr. 1344 (1959). The scattering of light, by nonabsorbing colloidal spheres, in the direction of the primary beam (forward direction) is calculated by means of the Mie theory as a function of α and m. The parameters considered are: $\alpha = 1$ (1) 15 for $m = 1.05$ (0.05) 1.30 and, in addition, $\alpha = 0.2$ (0.2) 15.2 for $m = 1.20$. In addition to the i values, the experimentally important quantity, I_{180}/I_{00} , obtainable by Zimm plots, is evaluated. Its variation with particle size is compared to that of the total turbidity. The performance of the hitherto almost exclusively used Rayleigh-Gans-Debye equation is tested quantitatively against the exact Mie data. The advantages of the "forward scattering method" for determining particle sizes are enumerated and a series of desirable definitions and clarifications of angular light scattering quantities are included.

535.525 : 548
OPTICAL METHOD FOR DETERMINING THE C AXIS OF RUBY BOULES. See Abstr. 5238

535.6.08 : 621.397.621
5596. MEASUREMENT AND EVALUATION OF COLOUR PURITY IN COLOUR TUBES. J.C.Francken and R.R.Bathelt. Acta electronica, Vol. 2, No. 1-2, 153-8 (1957-58).

"Physical problems of colour television" Conference paper (see Abstr. 1006/1958). Purity of the separate colour fields in colour tubes is one of the requirements of achieving good colour reproduction. After a short survey of possible causes of deterioration of the primary colour and of the known methods for measuring chromaticity, a colorimeter is described, especially designed for use with colour tubes. The instrument is based on the principle of visual additive mixing of three light sources. As such, three special cathode-ray tubes are used, fitted with the same phosphors as are used in colour tubes. A rapid evaluation of colour purity is thus possible, as well as a quantitative computation of chromaticity coordinates. The accuracy of the method is greatest in the vicinity of the primaries, a property that suits the purpose. Examples of measurements on actual tubes are given. For routine testing of tubes, in cases where reject limits have already been established, an objective method using coloured filters in combination with a photomultiplier is easier and faster. A short description is given of the combinations used for colour tube testing.

535.65
5597. PREDICTIONS OF SHIFTS IN COLOR APPEARANCE WITH A CHANGE FROM DAYLIGHT TO TUNGSTEN ADAPTATION. R.W.Burnham. J. Opt. Soc. Amer., Vol. 49, No. 3, 254-63 (March, 1959).

Comparisons are made between shifts in colour appearance reported by Wassef from W.D.Wright's laboratory and those predicted by the Burnham, Evans, Newhall (B-E-N) equations (Abstr. 4499/1959) for a change from daylight to tungsten adaptation. Prediction equations based on Wassef's data are also reported, and a comparison is made between the B-E-N and Wassef predictions for all of the Munsell colours specified by Kelly, Gibson, and Nickerson. Both sets of data lead to similar predictions, and charts are presented from which predictions for a wide variety of colours may easily be compared with the shifts in colour appearance found in practice.

535.683 : 535.218 : 538.2
ON PHOTOMAGNETISM AND PHOTOTROPY. I. See Abstr. 5873

535.683 : 538.2 : 535.218
5598. ON PHOTOMAGNETISM AND PHOTOTROPY. II. G.Kortüm, G.Littmann and W.Theilacker. Z. Naturforsch., Vol. 12a, No. 5, 401-4 (1957). In German.

It is shown that the phototropic modification of the derivative of dehydrodianthrone is not due to a triplet condition of the molecule, but most probably to a double radical, as has already been predicted from optical measurements. A.E. de Barr

535.7
PHYSIOLOGICAL OPTICS. VISION. See also the Section entitled "BIOPHYSICS. PHYSIOLOGICAL PHYSICS".

535.81
5599. MIRROR PROJECTION OBJECTIVE OF LARGE NUMERICAL APERTURE SUITABLE FOR TELEVISION USE. J.Pouleau. Acta electronica, Vol. 2, No. 1-2, 201-5 (1957-58). In French.

"Physcial problems of colour television" Conference paper (see Abstr. 1006/1958). Discusses various wide-aperture optical devices incorporating spherical concave mirrors and correcting elements, suitable for TV-projector lens uses. A new system based on the Schmidt plate principle is discussed and compared to objectives of known types, the system being considered both from the point of view of correction performance and of simplicity of manufacture. Correction of mirror spherical aberration is obtained by using a set of two complementary aspherical plates cemented together, the refractive indexes being somewhat different. The major merit of the system is, as calculation shows, that plate cutting accuracy requirements depend only upon the difference between the respective indexes of the two plates. Assuming a difference in the order of 5×10^{-3} , the accuracy requirement is approximately 3/100 mm, a degree of precision that can be easily achieved by purely mechanical means, without final correction. With Schmidt plates of conventional type, the accuracy requirement would have been 0.2 μ .

535.822
5600. INCREASED LATERAL RESOLUTION WITH OPTICAL MICROSCOPES. E.Menzel. Naturwissenschaften, Vol. 46, No. 3, 105 (1959). In German.

535.822.6
5601. DIFFRACTION IMAGES IN THE POLARIZING MICROSCOPE. H.Kubota and S.Inoué. J. Opt. Soc. Amer., Vol. 49, No. 2, 191-8 (Feb., 1959).

In the polarizing microscope set for extinction, only that image whose polarization has been altered is available to form an image. The lenses themselves introduce such an alteration by rotation of the plane of polarization of rays having oblique incidence. This paper shows that the diffraction image of a pinhole has the form $\sin 2\theta \cdot J_0(r)/r$, where θ and r are polar coordinates in the image plane. The image has four bright zones separated by a dark cross and the central pattern becomes a four-leaf clover form. The diffraction image of a point source through a plate of uniaxial crystal cut perpendicular to its optic axis (z-cut) is also a four-leaf clover when the polarizers are crossed. When the polarizers are parallel, the diffraction image becomes similar to that of an astigmatic system.

535.824.2
5602. INTERFEROMETRIC STUDY OF MICROSCOPE OBJECTIVES. Y.Ukita and J.Tsujiuchi. Optica Acta, Vol. 5, No. 1-2, 39-46 (March-June, 1958).

A specially designed microscope interferometer has been constructed which can observe the image of a point source or periodic pattern simultaneously with wave aberration. A series of experiments was made to elucidate the correspondence between the aberration and the image definition. Spot diagrams and response functions are also calculated numerically from the wave aberrations. The importance of the method of illumination was ascertained in these experiments by comparing perfectly coherent and incoherent illuminations.

535.825 : 539.1.07
ELECTRONIC PARTICLE LOCATING ATTACHMENT FOR MICROSCOPES. See Abstr. 4866

HEAT

5603. HEAT TRANSFER.

E.R.G.Eckert, J.P.Hartnett and T.F.Irvine, Jr.
Indust. engng Chem., Vol. 51, No. 3(II), 453-65 (March, 1959).

Review of recent literature (books, periodicals, conference proceedings and reports) on the following: Conduction; Channel flow; Boundary layer flow; Flow with separated regions; Transfer mechanisms; Natural convection; Convection from rotating surfaces; Transpiration and mass transfer cooling; Change of phase; Radiation; Liquid metals; Measurement technique; Heat transfer applications. The bibliography (arranged under the foregoing headings) comprises 318 references.

536.2 : 518.5 : 621.317.79

5604. AN ELECTRICAL-ANALOG METHOD FOR TRANSIENT HEAT-FLOW ANALYSIS. A.F.Robertson and D.Gross.

J. Res. Nat. Bur. Stand., Vol. 61, No. 2, 105-15 (Aug., 1958).

An electronic instrument is described which permits solution of transient heat-flow problems by use of direct analogy to electrical networks. The instrument is of the so-called "fast-time" type, simulating the transient involved in times of the order of 10^{-6} that of the thermal prototype. A photoformer type of input-signal generation is used and this, together with a variable-frequency master oscillator, permits flexibility of input-signal waveform and time scale. Some applications of the instrument to the field of fire research are described. The discussion of errors includes consideration of those resulting from the lumping of circuit elements.

536.2.01

5605. DOES HEAT PROPAGATE? P.Vernotte.

C.R. Acad. Sci. (Paris), Vol. 248, No. 1, 75-7 (Jan. 5, 1959).

In French.

536.2.01

5606. ON LINEAR HEAT PROBLEMS WITH ONE MOVING BOUNDARY. D.V.Redozubov.

Zh. tekhn. Fiz., Vol. 27, No. 9, 2149-57 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 9, 1993-2000 (Sept., 1957).

The general mathematical formulation of the one-dimensional heat conduction problem with one boundary moving according to a given law over the whole semi-infinite region $0 < x < \infty$ is considered. Solutions in a form suitable for numerical calculation are sought. The solutions obtained are limited to the case where the law of motion is of the form $y(t) = \beta t^2$.

S.Weintroub

536.2.022 : 532.13

THERMAL CONDUCTIVITY OF HOMOGENEOUS FLUIDS.

See Abstr. 5394

536.21 : 548

5607. MODEL FOR LATTICE THERMAL CONDUCTIVITY AT LOW TEMPERATURES. J.Callaway.

Phys. Rev., Vol. 113, No. 4, 1046-51 (Feb. 15, 1959).

A phenomenological model is developed to facilitate calculation of lattice thermal conductivities at low temperatures. It is assumed that the phonon scattering processes can be represented by frequency-dependent relaxation times. Isotropy and absence of dispersion in the crystal vibration spectrum are assumed. No distinction is made between longitudinal and transverse phonons. The assumed scattering mechanisms are (1) point impurities (isotopes); (2) normal three-phonon processes; (3) umklapp processes, and (4) boundary scattering. A special investigation is made of the role of the normal processes which conserve the total crystal momentum and a formula is derived from the Boltzmann equation which gives their contribution to the conductivity. The relaxation time for the normal three-phonon processes is taken to be that calculated by Herring for longitudinal modes in cubic materials. The model predicts for germanium a thermal conductivity roughly proportional to $T^{-3/2}$ in normal material, but proportional to T^{-2} in single-isotope material in the temperature range 50° - 100° K. Magnitudes of the relaxation times are estimated from the experimental data. The thermal conductivity of germanium is calculated by numerical integration for the temperature range 2 - 100° K. The results are in reasonably good agreement with the experimental results for normal and for single-isotope material.

536.212.2 : 537.311.31

5608. INVESTIGATION OF THE WIEDEMANN-FRANZ-LORENZ LAW FOR ORDERED AND DISORDERED PHASES OF A RANGE OF COPPER-PALLADIUM ALLOYS. F.P.Pott.

Z. Naturforsch., Vol. 13a, No. 3, 215-21 (March, 1958). In German.

Variations with temperature from 20° to 800° C of the electrical and thermal conductivity, Lorenz number and absorption coefficient, are measured for copper and copper-palladium alloys (0-59 Atomic % Pd). The parameters increase rapidly at the transition from a disordered to an ordered phase. The experimental value of the Lorenz number for the ordered phases is approximately equal to the theoretical value of Sommerfeld, but for the disordered phases it exceeds the theoretical value.

G.C.Williams

536.212.2 : 538.662

5609. AN ANOMALY OF THE RIGHI-LEDUC EFFECT IN Ni-Cu ALLOYS. W.Rindner and K.M.Koch.

Z. Naturforsch., Vol. 13a, No. 1, 26-8 (Jan., 1958). In German.

Values of the Hall, Ettinghausen, Nernst and Righi-Leduc coefficients, resistivity and thermal conductivity and the change in the coefficients with the addition of 1% Mn, are tabulated. A probable mechanism of conduction is discussed to explain the anomalous behaviour of the Righi-Leduc effect.

G.C.Williams

536.212.2 : 538.662

5610. MEASUREMENT OF THE RIGHI-LEDUC EFFECT ON SOME COPPER AND SILVER ALLOYS. H.E.Schmidt.

Z. Naturforsch., Vol. 13a, No. 10, 902-4 (Oct., 1958). In German.

The effect was measured as function of concentration on Ag-Pd, Cu-Ni and Cu-Au alloys. The Righi-Leduc coefficient, which should in the simplest case be equal to $R\sigma$ (R = Hall coefficient, σ = conductivity), was found to follow this relation only qualitatively.

L.Pincherle

536.222

5611. NEW DATA ON THE THERMAL CONDUCTIVITY OF WATER IN THE RANGE OF 10 TO 60° C. V.P.Frontas'ev.

Zh. tekhn. Fiz., Vol. 28, No. 8, 1839-44 (1958). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 3, No. 8, 1696-700 (Aug., 1958).

An anomaly was discovered in the temperature dependence of the thermal conductivity in the interval from 30 to 40° C.

536.24 : 533.72

5612. ON HEAT PHENOMENA ON ROTATING BODIES IN FREE MOLECULE FLOW. M.Z.v.Krzywoblocki and R.E.Bloomquist.

Acta phys. Austriaca, Vol. 12, No. 3, 237-45 (1959).

Derives the formulae and discusses the heat transfer phenomena on a rotating sphere and cylinder. The bodies are subject to both rotational and translational motions. No radiation phenomena are considered.

536.24 : 539.17

5613. RECENT INVESTIGATION ON HEAT TRANSFER IN WATER-COOLED REACTORS. G.Grass.

Atomkernenergie, Vol. 3, No. 5, 175-82 (May, 1958). In German.

The heat transfer of water flowing in tubes was investigated at flow rates of from 0.4 to 40 m/sec. Information was obtained on the influence of tube diameter, temperature and surface conditions.

536.24 : 532.542.8

5614. THE EFFECT OF INLET FLOW DISTURBANCES ON THE HEAT TRANSFER IN LIQUIDS IN PIPES AND ANNULAR CHANNELS. G.Grass.

Atomkernenergie, Vol. 3, No. 10, 382-8 (Oct., 1958). In German.

Results are presented for water flowing in the entrance length of a 1500 mm long tube with 10 to 12 mm diameter. The tests were carried out with constant heat input per unit length. The tested tube entrances were preceded by a hydrodynamic smoothing section or by orifices to be 1.5 to 17 times greater than that at the end of tube. The resulting entrance lengths were from 10 to 15 tube diameters over the Reynolds number range of 5000 to 30000 . A working formula is fitted to the results.

536.24

5615. THE DETERMINATION OF HEAT TRANSFER SURFACE FOR THE CASE OF ZERO TEMPERATURE DIFFERENCE BETWEEN COOLED AND COOLANT FLUIDS AT THE END POINT OF FLOW. I.I.Gel'perin and K.S.Minsker.

Zh. tekhn. Fiz., Vol. 27, No. 9, 2143-8 (1957). In Russian. English

translation in Soviet Physics — Technical Physics (New York), Vol. 2, No. 9, 1987-92 (Sept., 1957).

The heat transfer problem examined relates to the design of a heat exchanger used for the drying of gases or for the separation of gaseous products by the method of subcooling. Equations are derived which allow the determination of the required length of heat transfer tubing in cases where the usual equation $Q = kF\Delta t$ is inapplicable. From the equations the temperatures of the fluid streams at points in the heat exchanger tubes, and the corresponding quantities of released heat, may also be derived. S.Weintroub

536.24.01 : 539.17

TEMPERATURE DISTRIBUTION IN A GAS COOLED REACTOR. See Abstr. 5082

536.248

5616. HEAT TRANSFER TO WATER AND STEAM AT VARIABLE SPECIFIC HEAT (IN NEAR-CRITICAL REGION). Z.L.Miropol'skiĭ and M.E.Shitsman. Zh. tekh. Fiz., Vol. 27, No. 10, 2359-72 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 10, 2196-208 (Oct., 1957).

The results of an experimental investigation of local heat transfer coefficients to non-boiling water and superheated steam at pressures from 4 to 230 atm are discussed. It is concluded that the existing methods of calculation in this range of temperatures and pressures, where the values of Pr criterion vary according to the variation of the specific heat of the medium, are unsuitable. Calculation methods for the determination of α in the range investigated are suggested.

536.25

5617. CALCULATION BY SERIES EXPANSION OF THE HEAT TRANSFER IN LAMINAR, CONSTANT-PROPERTY BOUNDARY LAYERS AT NONISOTHERMAL SURFACES. N.Frössling. Ark. Fys., Vol. 14, Paper 12, 143-51 (1958).

A constant-property analysis of the heat transfer at a nonisothermal surface of a blunt body is made by means of series expansions of Blasius type for two dimensional and axially symmetrical laminar flow. The temperature of the surface and the velocity at the edge of the boundary layer are assumed to have power series distributions. Some new terms, containing universal functions, must be added to the existing solutions for heat transfer at isothermal surfaces, earlier published by the author (1940). Some of these functions are calculated numerically.

536.33

5618. CERTAIN NEW METHODS OF APPROXIMATE CALCULATION OF RADIATIVE HEAT TRANSFER. A.L.Lubnyĭ-Gertsyĭk. Zh. tekh. Fiz., Vol.27, No. 6, 1357-70 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 6, 1255-68 (June, 1957).

Methods are reviewed for both a stationary and a moving radiating medium. An approximate method of calculation for a selectively emitting suspended dust medium is put forward as well as a method for calculation of radiation of an emitting medium moving through a screen.

536.33 : 537.533 : 621.385.032.213.62

5619. THE EMISSION PROPERTIES OF ALUMINUM OXIDE AT HIGH TEMPERATURES. V.Ya.Frenkel'. Zh. tekh. Fiz., Vol. 27, No. 10, 2356-8 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 10, 2192-5 (Oct., 1957).

A determination was made of the integrated emissivity coefficient of alundum (sintered aluminium oxide) used as a coating material for the cathode heaters of indirectly-heated vacuum tubes in the temperature range 1000-1600° C. Experimental data from a previous measurement of the coefficient of thermal conductivity of alundum (J. Tech. Phys., 22, 1271, 1951) were used, and the non-linear differential equation of thermal conductivity was solved. The integrated emissivity coefficient of alundum $\epsilon_a = W_a/W_{bb}$, where W_a and W_{bb} are the specific emissive powers of alundum and of a perfect black body, respectively, is a slowly increasing function of temperature; its value changes from ~ 0.50 to 0.55 in the temperature range indicated above. The method described can be extended to the determination of the integrated emissivity coefficient of other materials.

536.4 : 538.541

HEATING OF A THIN CYLINDRICAL CONDUCTING LAYER BY A HIGH FREQUENCY MAGNETIC FIELD. See Abstr. 4830

536.4 : 539.2

PRODUCTION OF DISLOCATIONS IN GERMANIUM BY THERMAL SHOCK. See Abstr. 5154

536.4 : 534.2

THERMOELASTIC WAVES AND THERMAL SHOCK. See Abstr. 5432

536.4.031

5620. THE INFLUENCE OF CRUCIBLE MATERIAL AND GAS ATMOSPHERE ON THE SUPERCOOLING OF SUPERHEATED ANTIMONY MELTS. W.Mannchen and G.Hahn. Z. Naturforsch., Vol. 12a, No. 8, 671-2 (1957). In German.

The statistical evaluation of 18 000 cooling curves gave the following results: (1) under an atmosphere of argon or nitrogen no supercooling takes place in crucibles of quartz; (2) under the same atmospheres but with crucibles of sintered corundum a very strong supercooling of 70 deg C is observed, independent of superheating temperature; (3) with crucibles of quartz or sintered corundum and an atmosphere of hydrogen a supercooling of 15-20 deg C occurs. Possible reasons for these results are discussed. B.T.M.Willis

536.413

5621. MEASUREMENT OF THE COEFFICIENTS OF EXPANSION OF NaCl, LiF, KCl AND KBr BY THE FLOTATION METHOD. B.P.Konstantinov, Z.N.Efremova and G.Ya.Ryĭskin. Zh. tekh. Fiz., Vol. 28, No. 8, 1740-7 (1958). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 3, No. 8, 1604-11 (Aug., 1958).

The technique of the measurement of coefficients of expansion by the flotation method is described and the results of measurements for NaCl, KCl, KBr and LiF are given. The values obtained are in close agreement with the corresponding data of X-ray and interferometer measurements. The error of the method does not exceed 0.5-1.0%.

536.413 : 537.311.3

ELECTRICAL PROPERTIES AND THERMAL EXPANSION OF THE LAVES PHASES, CaMg_2 AND MgCu_2 . See Abstr. 4559

536.413 : 539.371

TEMPERATURE AND STRESS DISTRIBUTION IN A THERMOELASTIC SOLID. See Abstr. 5197

536.422 : 545.822

5622. SPECTRO-ANALYTICAL INVESTIGATION OF THE EVAPORATION PROCESS OF BINARY ALLOYS. E.Saur and E.Unger. Z. Naturforsch., Vol. 13a, No. 2, 72-9 (Feb., 1958). In German.

Various alloys (Ag-Cu, Sn-Cu, Sn-Pb, Sn-Ag, Ag-Al) are evaporated in vacuum, the successive condensed fractions being weighed and analysed spectroscopically. The compositions of the fractions follows Raoult's law. The method may thus be used to determine the vapour pressure of a metal by alloying it with a metal of known vapour pressure, also the thickness of thin evaporated metal films may be determined. G.F.Lothian

536.422.1 : 533.7

5623. FREE EVAPORATION OF ALKALI HALIDE CRYSTALS. G.M.Rothberg, M.Eisenstadt and P.Kusch. J. chem. Phys., Vol. 30, No. 2, 517-27 (Feb., 1959).

The evaporation of alkali halide crystals directly into vacuum was studied to determine (1) whether or not the velocity distribution of the evaporating molecules is Maxwellian, (2) the chemical composition of the vapour, and (3) the evaporation coefficients and heats of evaporation of the various molecular species. Single crystals of CsBr, CsI, LiF, and NaCl were used. The velocities of the evaporating molecules were analysed by means of the rotating cylindrical velocity selector used by Miller and Kusch. It was found that within relatively narrow limits of error the velocity distributions were Maxwellian. The vapour of CsI was found to contain only monomers; the others contained polymers in abundances different from those found in the saturated vapours. The heats of evaporation of NaCl monomers and dimers are, respectively, 61.7 ± 4.6 and 67.2 ± 4.6 kcal/mole, which yields heats of activation for evaporation of about 9 kcal/mole. Heats of activation also exist for LiF, but could not be determined from the data. The evaporation coefficients of the CsI and CsBr monomers are about 0.3; the evaporation coefficients of the polymers of NaCl and LiF are temperature dependent and are in the range 0.2 to 1.

536.423 : 551.575

5624. THE RELATIVE IMPORTANCE OF CONDENSATION AND COALESCENCE PROCESSES ON THE STABILITY OF A WATER FOG. G.A.H.Elton, B.J.Mason and R.G.Picknett. Trans Faraday Soc., Vol. 54, Pt 11, 1724-30 (Nov., 1958).

A theoretical analysis of the processes which influence the stability of a water fog contained in an isothermal enclosure is presented. The changes in droplet-size distribution brought about by coalescences between droplets of different sizes, and also by the distillation of water vapour from droplets smaller than average on to those larger than average, are computed. It is shown that, for a droplet population having initially a normal droplet size distribution, the evaporation-condensation process is the more important if the mean droplet radius is less than 7μ , assuming the collection efficiencies for droplets in this size range to be at least 0.1. Although the calculations have been made for a water fog, the theory is generally applicable to any similarly dispersed system. The effect of dissolved electrolytes in the droplets is to increase the stability of the fog.

536.423.1

5625. ON THE NATURE AND LOCATION OF BUBBLE NUCLEI IN BOILING FROM SURFACES.

S.G.Bankoff, A.J.Hajjar and B.B.McGlothin, Jr. J. appl. Phys., Vol. 29, No. 12, 1739-41 (Dec., 1958).

In the pool boiling of pure organic liquids from a reproducible platinum surface, an initial temperature overshoot is observed before the surface breaks into nucleate boiling. A logarithmic plot of heat flux versus temperature excess has a slope of 3.5 for the first traverse but subsequent traverses give a reproducible line having a higher slope and surface temperature. Vigorous heating in air restores the surface to its original condition. These results are explained in terms of the trapped-bubble hypothesis by assuming that many potential vapour traps on the surface are filled with liquid initially, and fill with vapour once boiling commences. The gradual increase in surface temperature for a given flux is attributed to the progressive deaeration of the nucleating centres by dilution with vapour. To reconcile the fact of surface aeration with the existence of an initial temperature overshoot, it is necessary to assume that the temperature drift is due primarily to the removal of sorbed air, resulting in decrease in contact angle, corresponding to improved wetting of the surface. These experiments also indicate that the bulk of the active nuclei are on the heating surface, rather than on dust particles in the liquid.

536.423.15

5626. THE USE OF RADIOACTIVE ISOTOPES FOR DETERMINING SATURATED VAPOUR PRESSURE. H.Nesmeyanov.

Atomnaya Energiya, Vol. 3, No. 9, 227 (1957). In Russian. English translation in: Internat. J. appl. Radiation and Isotopes, Vol. 4, No. 1-2, 16-29 (Dec., 1958).

A brief survey is given of methods, techniques and experimental arrangements. Determination of the vapour pressure by a static method from a direct measurement of the radioactivity of the vapour with a counter, from the activity determined by a photographic method or by radio-chemical methods, is described. Papers concerned with the measurement of the vapour pressure by the boiling point and the jet-method are discussed. The variations in Langmuir's method depending on the evaporation of material from a filament and from a crucible are analysed. The vapour pressure of liquid metals and liquid alloy components is calculated from the activity of the condensate. A variation of the method is described in which the vapour pressure is determined from the radioactivity of part of the condensate. The integral and differential variations (integral with collection of all the vapour and differential with collection only of part of the vapour phase) of Knudsen's method are discussed, together with results of vapour pressure measurements of elements and alloy components by radiometric analysis of the condensate. Application at the isotope exchange method is described. A table is given showing the comparative sensitivity of the different methods of measuring vapour pressure.

536.46

5627. IGNITION OF COMBUSTIBLE GASES. G.Rosen. J. chem. Phys., Vol. 30, No. 1, 298-303 (Jan., 1959).

The ignition of a combustible gas was studied by obtaining an approximate solution to the coupled equations of unsteady fluid flow, mass and heat diffusion, and chemical kinetics. At various stages, the theory is contrasted with the "excess enthalpy hypothesis". It is shown that the empirically established minimum ignition energy can be deduced from the well-established laws, without invoking the ad hoc "excess enthalpy hypothesis".

5628. GASEOUS DETONATIONS. XI. DOUBLE WAVES. M.Chen and G.B.Kistiakowsky.

J. chem. Phys., Vol. 29, No. 3, 506-11 (Sept., 1958).

For Pt X, see Abstr. 897 (1959). Photographic studies of detonations of benzene-oxygen mixtures with the slit and rotating drum camera arrangement showed under well defined conditions the occurrence of a sharp luminous front receding at a constant rate (~ 73 m/sec) from the detonation wave front. The same phenomenon was observed in several other hydrocarbon-oxygen mixtures but not in mixtures of hydrogen and oxygen. Measurements of gas densities by the method of X-ray absorption gave confirmatory evidence that the secondary fronts are shock waves in the domain of the rarefaction wave. A qualitative theory of the secondary wave is developed by analogy with the steady supersonic gas flow through convergent-divergent nozzles. It is concluded that the secondary wave is due to entropy increase in the rarefaction wave, caused by a spontaneous reaction. Detonation velocity measurements of benzene-oxygen mixtures and thermodynamic velocity calculations show indeed that thermodynamic equilibrium is not attained in the C-J state of the detonation wave, but the nature of the lagging chemical reaction cannot be established.

536.46

5629. GASEOUS DETONATIONS. XII. ROTATIONAL TEMPERATURES OF THE HYDROXYL FREE RADICALS.

G.B.Kistiakowsky and F.D.Tabbutt.

J. chem. Phys., Vol. 30, No. 2, 577-81 (Feb., 1959).

For Pt XI, see preceding abstract. An apparatus is briefly described for photographing of the ultraviolet absorption spectrum of the hydroxyl free radicals in gaseous detonation waves with a time resolution of a few microseconds. Using two mixtures, $2H_2 + O_2$ and $2H_2 + O_2 + 0.075 C_2H_2$ at 20 mm pressure, changes were studied in the absorption spectra with the progress of chemical reactions in a detonation wave. Densitometry of the absorption lines in the R_2 branch of the O—O band in the $^2\Sigma^+ \rightarrow ^2\Pi$ transition, combined with the use of the iso-intensity method, showed that the "rotational temperatures" of the radicals in their ground electronic state are initially much higher than the "translational temperatures" calculated from the experimentally observed and elsewhere reported density-time curves in detonation waves of similar gas mixtures. After the completion of the reactions and the attainment of the Chapman-Jouguet state the rotational temperature was found to be slightly lower than the calculated equilibrium temperature, which is attributed to systematic experimental errors. The observed initial lack of equilibration between the translational and rotational temperatures is interpreted to mean that the lifetime of hydroxyl radicals in partially reacted mixtures is comparable to their rotational relaxation time, i.e., is of the order of the time for ten collisions.

536.48 : 532.51

5630. THIRD AND FOURTH SOUND IN LIQUID HELIUM II.

K.R.Atkins.

Phys. Rev., Vol. 113, No. 4, 962-5 (Feb. 15, 1959).

This article discusses the possible existence of two hitherto undetected types of wave propagation in liquid helium II. Third sound is a surface wave of long wavelength on a liquid helium film during which the normal component remains stationary and the superfluid component oscillates parallel to the wall. To treat this properly it is necessary to consider temperature changes and evaporation from the surface of the film. Fourth sound may exist in narrow two-sided channels. The normal component again remains stationary and the superfluid component oscillates parallel to the wall, but the width of the channel must remain fixed and so there are oscillations in both total density and temperature.

536.48 : 534.22

VELOCITY OF SOUND IN LIQUID He^3 . See Abstr. 5440

536.48 : 536.423

5631. EVAPORATION EFFECTS DURING SUPERFLOW OF LIQUID HELIUM II. K.R.Atkins, B.Rosenbaum and H.Seki.

Phys. Rev., Vol. 113, No. 3, 751-4 (Feb. 1, 1959).

The rate of distillation of helium between two liquid surfaces at different temperatures was measured and found to be in approximate agreement with simple kinetic theory. The influence of evaporation on the thermal effects accompanying film flow is discussed. It seems unlikely that the decrease in the rate of film flow at small level differences can be explained in terms of these thermal effects.

536.48 : 539.14

CONDITIONS OF SUPERFLUIDITY OF NUCLEAR MATTER.

See Abstr. 4987

536.5 : 534.222.2

THERMODYNAMICS

TEMPERATURE AND HEAT CAPACITY OF "PLEKSI GLASS"
($C_6H_8O_2$)_n COMPRESSED BY A SHOCK WAVE. See Abstr. 5444

536.627

5632. A MICRO-CALORIMETER FOR MEASUREMENT OF SMALL HEAT CHANGES. S.N.Bhattacharya and S.K.Das. Indian J. Phys., Vol. 33, No. 1, 36-40 (Jan., 1959).

Designed to study the heats of mixing of binary liquid systems. The accuracy of the calorimeter is better than $\pm 0.5\%$ and sensitivity is 0.002 J/mm. The vapour phase has been eliminated. A thermally-lagged multi-jacket is incorporated.

536.629

5633. USE OF A RADIATION-CALORIMETER IN MEASUREMENT OF STORED ENERGY IN IRRADIATED GRAPHITE. M.S.Wechsler, R.R.Coltman, R.H.Kernohan and M.C.Wittels. J. appl. Phys., Vol. 30, No. 1, 42-5 (Jan., 1959).

The measurement of the stored energy of graphite taken from the lattice of the ORNL Graphite Reactor is described. The release of 26 cal/gm of stored energy was observed upon heating to 218°C. The measurements were made using a new technique that depends upon the transfer of heat by radiation from the walls of the calorimeter to the sample.

536.631 : 537.312.62

5634. SPECIFIC HEAT OF GALLIUM AND ZINC IN THE NORMAL AND SUPERCONDUCTING STATES. G.Seidel and P.H.Keesom.

Phys. Rev., Vol. 112, No. 4, 1083-8 (Nov. 15, 1958).

By using a He³ cryostat the specific heat of Ga was measured between 0.35° and 4.3°K, and that of Zn between 0.42° and 4.2°K. Measurements on Ga in the normal state indicate that the coefficient of the electronic specific heat, γ , is 0.601 mJ/mole (°K)² while the Debye characteristic temperature θ at 0°K is 317°K. For Zn, $\gamma = 0.640$ mJ/mole (°K)²; $\theta = 309^\circ$ K. The electronic specific heat in the superconducting state, C_{es} , for both metals for T well below the transition temperature, T_C can be represented by the expression $C_{es} = a\gamma T_C e^{-bT_C/T}$. For Ga, $T_C = 1.087^\circ$ K, $a = 7.0$, and $b = 1.35$. The Zn sample measured has a broad transition, T_C taken as 0.852°K. Also for Zn, $a = 6.4$ and $b = 1.27$. The magnetic threshold field curves are calculated from these specific heat results. The critical field at 0°K for Ga is 59.4 Ga and for Zn, 53.4 Ga. In comparing these measurements with the calorimetric results of other superconductors a definite variation is noted in the parameters a , b , $(C_{es} - C_{en})/\gamma T_C$ at T_C , and $\gamma T_C^2/V_m H_0^2$. There appears to be a correlation between the magnitudes of these quantities and the transition temperature.

536.631

5635. HEAT CAPACITY OF PSEUDO-COPPER BELOW 4.2°K. G.L.Guthrie.

Phys. Rev., Vol. 113, No. 3, 793-5 (Feb. 1, 1959).

Heat-capacity measurements were made on two face-centred cubic alloys of the type $Cu_{1-2x}Zn_xNi_x$ at temperatures below 4.2°K for the values $x \approx 0.03$ and $x \approx 0.08$. The heat capacity was found to obey a law of the type $C_V = \gamma T + (464.5/\theta D^3)T^3$ cal/mole (°K). The Debye characteristic temperature θD is nearly the same as that for pure copper. For an alloy having $x \approx 0.03$, θD is approximately 1% higher than θD for pure copper. However, γ increases rapidly with increasing x , and is approximately 20% than the γ for pure copper when $x \approx 0.03$. The results are found to be incompatible with a rigid-band model approach to alloy theory.

536.654

5636. MASS SPECTROMETRIC STUDY OF HEATS OF SUBLIMATION OF DYSPROSIUM, SAMARIUM, THULIUM, AND YTTERBIUM. W.R.Savage, D.E.Hudson and F.H.Spedding. J. chem. Phys., Vol. 30, No. 1, 221-7 (Jan., 1959).

The flux of atoms from a Knudsen-type effusion cell was studied by means of a mass spectrometer. The heat of sublimation was obtained from the dependence of the ion current upon the cell temperature by means of the Clausius-Clapeyron equation. The method was used to obtain heat of sublimation values for dysprosium, samarium, thulium and ytterbium. The results were: Dy, 69.3 ± 0.6 kcal/mole for vaporization at 1215°K; Sm, 48.7 ± 0.4 kcal/mole for vaporization at 811°K; Tm, 56.2 ± 0.4 kcal/mole for vaporization at 937°K; and Yb, 39.5 ± 0.5 kcal/mole for vaporization at 667°K.

536.631 : 537.311.33

SPECIFIC HEAT OF GERMANIUM AND SILICON AT LOW TEMPERATURES. See Abstr. 4583

536.7

5637. THERMODYNAMICS OF NONSTOICHIOMETRIC NICKEL TELLURIDES. II. DISSOCIATION PRESSURES AND PHASE RELATIONS OF TELLURIUM-RICH COMPOSITIONS. E.F.Westrum, Jr and R.E.Machol.

J. chem. Phys., Vol. 29, No. 4, 824-8 (Oct., 1958).

For Pt I, see Abstr. 8740 (1958). Dissociation pressures of tellurium over liquid and solid nickel telluride solutions were measured with a silica Bourdon gauge at compositions corresponding to $NiTe_{1.5}$, $NiTe_{1.7}$, $NiTe_{1.9}$, $NiTe_{2.0}$, and $NiTe_3$ at temperatures up to 780°. Modifications of the manometric technique are described which permit accuracies of 0.1 mm pressure and 0.1° at high temperatures with corrosive substances where the pressure is sensitive to impurities or to composition changes. The results, together with data on the vapour pressure of pure tellurium, define the partial molal free energies and entropies of tellurium and, together with direct eutectic temperature measurement, delineate features of the phase diagram for compositions with more than 60 atomic % tellurium.

536.7

5638. THERMODYNAMIC STUDY OF SiC UTILIZING A MASS SPECTROMETER. J.Drowart, G.De Maria and M.G.Inghram. J. chem. Phys., Vol. 29, No. 5, 1015-21 (Nov., 1958).

The sublimation of hexagonal SiC has been studied under equilibrium conditions. The predominant gaseous species above SiC are Si, SiC₂ and Si₂C. By combining the heat of formation of gaseous Si from solid SiC and the known standard heat of formation of SiC, a value of 113 kcal/g atom is obtained for the heat of sublimation of Si at 298°K. From the measured partial pressures, using estimated free energy functions, dissociation energies for Si₂, Si₃, SiC, SiC₂, Si₂C, Si₂C₂, Si₂C₃ and Si₃C are calculated and compared with previously known dissociation energies for group IVB molecules.

536.7

5639. HEAT CAPACITIES AND THERMODYNAMIC PROPERTIES OF THE PYRRHOTITES FeS AND Fe_{0.877}S FROM 5 TO 350°K. F.Gronvold, E.F.Westrum, Jr and C.Chou. J. chem. Phys., Vol. 30, No. 2, 528-31 (Feb., 1959).

Heat capacities were measured from 5 to 350°K for two pyrrhotites at the iron-rich limit (Fe_{1.000}S) and the sulphur-rich limit (Fe_{0.877}S) of the homogeneity range. The heat-capacity curves follow the normal sigmoid shape with the exception of an upward trend for Fe_{1.000}S above 300°K, and two small, broad humps for Fe_{0.877}S near 8 and 30°K. From these data the entropy and enthalpy functions were calculated. At 298.15°K the values of C_p , $S^\circ - S_0^\circ$, and $(H^\circ - H_0^\circ)/T$ are 12.08, 14.415, and 7.496 cal/mole °K, respectively, for Fe_{1.000}S, and 11.92, 14.529, and 7.396 cal/mole °K for Fe_{0.877}S. The values on FeS are lower by approximately 10% over the range 58 to 296°K than those previously reported in the literature.

536.7 : 541.122.4

5640. THERMODYNAMIC PROPERTIES OF GASES AT HIGH TEMPERATURE. I. CHEMICAL EQUILIBRIUM AMONG MOLECULES, ATOMS, AND ATOMIC IONS CONSIDERED AS CLUSTERS. H.W.Woolley.

J. Res. Nat. Bur. Stand., Vol. 61, No. 6, 469-90 (Dec., 1958).

The equilibrium thermodynamic properties of gaseous mixtures at high temperatures are treated by an extension of the cluster theory of Ursell (1927), omitting the assumption of additivity of pair energies. An effective partition function is introduced, which is a convenient function in expressing the increase of the partition function for the entire gas due to the joining together of the parts of the cluster. The law of mass action and the dependence of second and third virial coefficients upon the cluster integrals for pairs and triples of molecules in a mixture have been obtained therefrom. Extension to a partially ionized gas is made by incorporating Mayer's cluster-based extension of the Debye-Hückel theory.

536.71

5641. THE SECOND VIRIAL COEFFICIENTS OF PYRIDINE AND BENZENE AND SOME METHYL HOMOLOGUES BETWEEN 135° AND 165°C. J.D.Cox and R.J.L.Andon. Trans Faraday Soc., Vol. 54, Pt 11, 1622-9 (Nov., 1958).

The second virial coefficients of pyridine, α -picoline, β -picoline, γ -picoline, 2 : 6 lutidine, benzene, toluene, o-xylene, m-xylene, and p-xylene were determined from vapour compressibility measurements at 135.8°, 151.0°, and 164.6°C. The values are combined with

earlier measurements to yield equations for the temperature dependence of the second virial coefficients of these compounds. The results are discussed in relation to the principle of corresponding states, and are also used to obtain values of the force constants for molecular interaction. Finally, the second virial coefficients are used in conjunction with other data to obtain values for the latent heats of vaporization of the ten compounds at their normal boiling points.

536.715

5642. INTERNAL ENERGY-COMPRESSIBILITY-TEMPERATURE EQUATION FOR AIR IN DISSOCIATIVE AND IONIC EQUILIBRIUM. P.Winchell.

J. chem. Phys., Vol. 29, No. 4, 687-8 (Oct., 1958).

Based on the real gas data of Hilsenrath and Beckett, an equation $E/RT = f(Z, T)$ is proposed to describe air in dissociative and ionic equilibrium over wide state-variable intervals. Used in conjunction with a suitable real gas state equation, e.g. $Z = g(\rho, T)$, an entropy-compressibility-density relation, and pertinent conservation equations, the proposed equations should complete a realistic, consistent set of dynamic and thermodynamic equations. The proposed equation exhibits excellent agreement with the data in sample calculations.

536.722

5643. THE TEMPERATURE DEPENDENCE OF THE ENTHALPY OF FORMATION, FREE ENTHALPY OF FORMATION AND DISSOCIATION CONSTANT OF FLUORINE. J.Himpan.

Z. Naturforsch., Vol. 13a, No. 3, 239 (March, 1958). In German.

The remarkably low experimental value for the enthalpy of formation of fluorine given by Cole, Farber and Elverum (Abstr. 5089/1952) was later corrected by Sanderson (Abstr. 5835/1954) to $\Delta H_f^\circ = 95 \text{ kcal./mol. (298.16}^\circ\text{K)}$, and this value is now confirmed. In consequence, the values of ΔH are recalculated and tabularized for the temperature range $298.16^\circ\text{--}5000^\circ\text{K}$, and also the corresponding data for the free enthalpy of formation ΔG_f° and the dissociation constant of fluorine (corresponding to $F_2 \rightleftharpoons 2F$). H.H.Hodgson

536.75

5644. EXPRESSION IN TERMS OF MOLECULAR DISTRIBUTION FUNCTIONS FOR THE ENTROPY DENSITY IN AN INFINITE SYSTEM. R.E.Nettleton and M.S.Green.

J. chem. Phys., Vol. 29, No. 6, 1365-70 (Dec., 1958).

An expression for the entropy in a finite subvolume of an infinite fluid, originally proposed by Stratonovich on the basis of information theory, is rewritten in terms of functions related to the potentials of average force. The result exhibits a correction to the corresponding expression obtained by H.S.Green (1952) for a finite system, in the form of a series in powers of the concentration, of which the first terms have been investigated by Richardson. By neglect of correlations of three or more molecules and powers of the density higher than the third, the result is specialized to the case of a gas of low density, for which the configurational entropy per molecule is calculated with use of the radial distribution obtained by Kirkwood for hard-sphere and hard-core Lennard-Jones potentials.

536.76 : 548.1

5645. STATISTICAL THEORY OF PHASE-CHANGE IN PARAFFIN CRYSTALS. F.Eicker.

Z. Naturforsch., Vol. 13a, No. 2, 126-43 (Feb., 1958). In German.

The entropies of the two lattices are calculated by the method of Kikuchi (Abstr. 5134/1951) using the Ising model. The free energy of each lattice is obtained, and the transition temperature found by equating free energies; values for the latent heat of the transformation are also obtained. These are of the same order as the rather sparse experimental data that are available.

A.R.Stokes

536.764

5646. THERMODYNAMICS OF MARTENSITIC TRANSFORMATIONS. M.Hillert.

Acta metallurgica, Vol. 6, No. 2, 122-4 (Feb., 1958).

In the consideration of these it is shown to be more advantageous to begin with the equation $dU - TdS + W \leq 0$ than with the Gibbs or Helmholtz free energy functions, and avoids the danger of (procedure) error (see for example Krisemont et al, Revue de Metallurgie, Vol. 51, 401, 1954). Comparison with the results of existing experiments is made.

W.Good

ELECTRICITY

537.081 : 538.081 : 53.081

EXPLANATION OF ELECTRIC AND MAGNETIC CONSTANTS AND UNITS. See Abstr. 5341

ELECTROSTATICS . DIELECTRICS

537.222

5647. MEASUREMENT OF DIELECTRIC SURFACE CHARGE DENSITY AND TOTAL CHARGE DENSITY OF A CONDENSER. P.Shao.

Phys. Rev. Letters, Vol. 2, No. 2, 41-3 (Jan. 15, 1959).

These are measured as a function of applied potential using a condenser consisting of a fixed electrode, a sheet of mica as dielectric and a portable plate of a 10 ohm cm n-type single crystal of silicon. It is shown that during the charging of the condenser some of the charge is transferred to the mica surface and it is suggested that this charge is associated with localized electronic states in the forbidden energy gap of the dielectric, which can be emptied or filled without affecting the insulating properties of the dielectric.

A.E.Kay

537.224 : 541.13 : 621.357.035.2 : 621.317.335

5648. CAPACITIES OF SOLID METAL-SOLUTION INTERFACES. J.J.McMullen and N.Hackerman.

J. Electrochem. Soc., Vol. 106, No. 4, 341-6 (April, 1959).

An electric analogue of the metal-solution interface was assumed and E versus t changes were deduced mathematically for application of a square-wave voltage. The analysis was verified using actual electric components, and it was demonstrated that the component of capacity could be measured readily. The method was applied with some success to each of the following systems: mercury in 0.1N Na_2SO_4 , platinum, silver, copper, aluminium, and tantalum in 1N Na_2SO_4 .

537.226 : 621.315.61

5649. DIGEST OF THE LITERATURE ON DIELECTRICS.

VOLUME XXI — 1957. Edited by J.Hart and R.A.Soderman.

Washington: National Academy of Sciences — National Research Council Publication 599 (1958) 283 pp.

This annual volume is prepared by the Committee on Digest of Literature of the Conference of Electrical Insulation, Division of Engineering and Industrial Research. The papers are: Instrumentation and measurements, R.A.Soderman and H.P.Hall (1-30) 263 refs. Table of dielectric constants and dipole moments, K.H.Illinger (31-52) 79 refs. Molecular and ionic interactions in dielectrics, T.D.Callinan (53-69) 118 refs. Conduction phenomena in solid dielectrics, F.R.Lipsett and J.Rolfe (71-90) 142 refs. The breakdown of dielectrics, J.J.Chapman and L.J.Frisco (91-109) 163 refs. Piezoelectric materials, W.R.Cook, Jr and H.Jaffe (111-27) 188 refs. Ferroelectric materials, P.J.Franklin (129-39) 107 refs. Ferromagnetic materials, J.B.Goodenough, K.Dwight, N.Menyuk and D.O.Smith (141-213) 457 refs. Rubber and plastic insulation, S.Palinchak and C.W.Hamilton (215-241) 197 refs. Insulating films, H.A.Birdsall (243-57) 54 refs. Insulating liquids and their applications, J.E.Gibbons (259-68) 34 refs. Ceramic insulation, K.G.Skinner (269-75) 28 refs. Electrical machinery and transformers, M.L.Manning and G.L.Moses (277-82) 41 refs.

537.226.08 : 621.317.374

5650. THE METHOD OF THICKNESS DOUBLING: A PROCEDURE FOR DETERMINING COMPLEX PERMITTIVITIES IN THE HIGHEST FREQUENCY RANGE BY MEANS OF STANDING WAVES. E.Biller.

Z. angew. Phys., Vol. 10, No. 10, 458-9 (Oct., 1958). In German.

The calculations necessary to evaluate permittivity and loss tangent of dielectrics from standing wave measurements are much simplified if two successive tests are made with specimens of lengths in the ratio of 2 : 1.

K.W.Plessner

537.226.1

5651. THE CALCULATION OF ONSAGER'S REACTION FIELD FOR A PARTICULAR MODEL. B.V.Paranjape.

Rep. Brit. Elect. Res. Assoc., Rep. L/T371, 8 pp. (1958).

In Onsager's formula for the dielectric constant, the interaction

of a dipole with its surroundings is calculated from the static dielectric constant. Several authors objected to this on the ground that the field of a frequently turning dipole is far from being static. Others do not consider these objections valid, and in this report it is demonstrated on a very simple model that it is in fact correct to calculate the dipolar interaction from the static electrical properties.

5652. TEMPERATURE DEPENDENCE OF DIELECTRIC CONSTANT. Y.P. Varshni and G.P. Srivastava. Z. phys. Chem. (Leipzig), Vol. 210, No. 3-4, 144-50 (March, 1959).

The following formula is suggested:

$$\epsilon = A + \frac{B}{T + C},$$

where A, B and C are constants for a given substance. The dielectric constants of water and 9 organic liquids are calculated from this formula for various temperature ranges.

5653. A POSSIBLE MODEL FOR THE SWITCHING OF BARIUM TITANATE CRYSTALS. J.C. Burfoot. Proc. Phys. Soc., Vol. 73, Pt 4, 641-9 (April, 1959).

It is suggested that an adequate explanation of the switching current in barium titanate single crystals can be given by a domain model which includes an effective wall mass and a "viscous" opposition, but no depolarizing field and no specific representation of impurities or lattice imperfections. The form of the switching current and also its variations with the magnitude of the switching field can be derived, if the domain growth is controlled by the nucleation process, and if the nucleation rate lies within certain limits.

5654. MICROWAVE ABSORPTION AND MOLECULAR STRUCTURE IN LIQUIDS. XXV. MEASUREMENTS OF DIELECTRIC CONSTANT AND LOSS AT 3.1 mm WAVELENGTH BY AN INTERFEROMETRIC METHOD. R.W. Rampolla, R.C. Miller and C.P. Smyth. J. chem. Phys., Vol. 30, No. 2, 566-73 (Feb., 1959).

For Pt XXIV see Abstract. 1412 (1959). The theory and apparatus for the method are described. The 3.1 mm wave is obtained as the fourth harmonic from a K-band reflex klystron. The probable error of the dielectric constant measurements is 0.5%, while that of the loss measurements is 2-5% for high loss liquids. For very low losses, only an upper limit can be obtained because of the small amount of harmonic energy obtainable. Four tetrahalogenated methanes, three substituted benzenes, two methylquinolines, three alcohols, and water were measured and the results examined in the light of measurements at lower frequencies. All of the liquids but the three alcohols give 3 mm points lying satisfactorily on Cole-Cole arc plots drawn through points previously obtained at lower frequencies. The losses observed at 3 mm are, however, somewhat higher than calculated, indicating the probable presence of overlapping absorption regions at still higher frequencies. The apparent optical dielectric constant value 6.0 found for water evidences further absorption at much shorter wavelengths. Methyl, ethyl, and n-octyl alcohols show absorption regions at frequencies too high to be attributable to molecular dipole orientation. The critical or maximum absorption wavelengths found for these additional high-frequency absorption regions are 0.57 cm for ethyl alcohol and 0.50 cm for n-octyl alcohol.

5655. THE DIELECTRIC BEHAVIOUR OF ALKALI HALIDES (CRYSTALS) WITH NaCl STRUCTURE. S. Haussthl. Z. Naturforsch., Vol. 12a, No. 5, 445-7 (1957). In German.

The dielectric constant of single crystals of the sixteen substances lithium, sodium, potassium and rubidium fluoride, chloride, bromide and iodide have been measured to 1% from 100 kc/s to 20 Mc/s and from 20° to 110°C. The variation with frequency and temperature was less than 1%. The variation of the molar polarization $P_m = [M(\epsilon - 1)/\rho(\epsilon + 2)]$ with cation and anion is discussed. The constancy of the product of P_m and the elastic constant c_{11} is noted ($P_m \times c_{11} \approx 8 \times 10^{-12}$ erg).

J.G. Powles

5656. STUDY OF THE SECOND-ORDER FERROELECTRIC TRANSITION IN TRI-GLYCINE SULFATE. S. Triebwasser. I.B.M. J. Res. Developm., Vol. 2, No. 3, 212-17 (July, 1958).

Results of measurements of the dielectric constant, dielectric nonlinearity and spontaneous polarization of triglycine sulphate are

given. These data demonstrate clearly that this material exhibits a second-order ferroelectric transition. The properties discussed are described in terms of the usual expansion of the free energy in even powers of the polarization:

$$F(P, T) = F(O, T) + A(T - T_0)P^2 + BP^4 + CP^6,$$

where A, T_0 , B and C are constants, and T and P are the temperature and polarization, respectively. From the various data, it is found that $A = 1.96 \times 10^{-3}$ (deg C) $^{-1}$, $T_0 = 49.8^\circ$ C, $B = 2.0 \times 10^{-10}$ (e.s.u./cm ^{2}) $^{-2}$ and $C = 8.4 \times 10^{-19}$ (e.s.u./cm ^{2}) $^{-4}$. From these results, the nonlinearity of the dielectric constant above the Curie point is calculated at various temperatures.

5657. POLARIZATION REVERSAL IN TRI-GLYCINE FLUOBERYLLATE AND TRI-GLYCINE SULFATE SINGLE CRYSTALS. C.F. Pulvari and W. Kuebler. J. appl. Phys., Vol. 29, No. 12, 1742-6 (Dec., 1958).

Time and field dependence of switching current at room temperature was studied for tri-glycine fluoberyllate as well as for tri-glycine sulphate. It is shown that the theory describing polarization reversal in BaTiO $_3$ c-domain crystals based on observed time and field dependence of polarization $P = f(E, t)$ developed by the authors is applicable. Activation field α and mobility μ appearing in the basic equation were determined for tri-glycerine fluoberyllate (TGFB) as well as for tri-glycine sulphate (TGS). For both materials, α , as well as μ was found to be independent of crystal thickness indicating that no skin properties are involved. The value of α for TGFB and TGS is lower by a factor of at least 2.5 and 3, respectively, than for BaTiO $_3$. Compared to values for BaTiO $_3$, the value of μ for TGFB and TGS is lower for thick crystals and higher for relatively thin crystals ($\delta < 8 \times 10^{-3}$ cm). Switching conductivity for both materials is given. Both TGFB and TGS were investigated under various pulsed conditions and no fatigue effect was found. The hysteresis losses in both materials are less by a factor of about 10 than those for BaTiO $_3$.

5658. CERTAIN PECULIARITIES IN THE ELECTRICAL PROPERTIES OF CERAMIC DIELECTRICS BASED ON ZIRCONIUM AND NIOBIUM OXIDES. K.E. Lisker. Zh. tekh. Fiz., Vol. 28, No. 11, 2428-33 (1958). In Russian.

Dielectric properties of ZrO $_2$ -Nb $_2$ O $_5$ solid solutions are reported. A new compound, niobium tetrazirconate (Nb $_2$ O $_5$ ·4ZrO $_2$), is probably formed at 80% ZrO $_2$ + 20% Nb $_2$ O $_5$. The properties of ZrO $_2$ -Nb $_2$ O $_5$ solid solutions and of Nb $_2$ O $_5$ ·4ZrO $_2$ were found to depend on the amounts and nature of impurities present in the Nb $_2$ O $_5$ used to prepare these materials. At room temperature the permittivity (ϵ) of Nb $_2$ O $_5$ ·4ZrO $_2$ was 65, $\tan \delta$ (at 10 ^{3} and 10 ^{6} c/s) $6-9 \times 10^{-4}$, and the temperature coefficient of permittivity $+180-200 \times 10^{-6}$. Temperature dependences of ϵ and $\tan \delta$, and the temperature coefficient of ϵ , are shown in graphs for temperatures from -150° to +300°C.

A. Tybulewicz

5659. DOMAIN STRUCTURE OF WO $_3$ SINGLE CRYSTALS. S. Sawada and G.C. Danielson. Phys. Rev., Vol. 113, No. 4, 1005-8 (Feb. 15, 1959).

Transparent single crystals of WO $_3$ in the form of plates as large as 10 mm $\times$ 10 mm, were prepared by a sublimation method. The domain structure of these crystals was investigated from room temperature to 1350°C, and a new and peculiar domain structure was found between 740°C and 810°C. This domain structure is probably associated with the change in crystal structure from orthorhombic to tetragonal. Lattice parameters determined optically from measurements of the angle between extinction positions of two neighbouring domains agreed well with those obtained by X-ray analysis. The shift in the absorption edge to the infrared at 740°C was observed to take place for light polarized in a direction perpendicular to the c axis, but not for light polarized parallel to the c axis.

5660. FERROELECTRIC HYSTERESIS AND AFTER-EFFECT, PHENOMENA IN ROCHELLE SALT. H.E. Muser. Z. angew. Phys., Vol. 10, No. 6, 249-54 (June, 1958). In German.

A central constriction is observed in the hysteresis loop of crystals which have been rested (aged) for a period of time at a constant temperature. Application of a high a.c. field, or reheating above the Curie point, removes the constriction, and at the same time a rise in the low-field permittivity occurs. A theory of these phenomena is put forward which is based on the formation of internal

stresses when the crystal becomes ferroelectric and their gradual decay while the crystal is resting, due to domain rearrangements, impurity migration and charge accumulations. The domain structure of the rested crystal being favoured, a smaller coercive field is required for some domains than for others and this accounts for the observed shape of the hysteresis loop. K.W.Plessner

537.226.2

5661. DOMAIN FORMATION IN FERROELECTRICS.

A.Jaskiewicz.

Acta phys. Polon., Vol. 16, No. 3, 227-9 (1957).

Discusses how the formation and behaviour of the c-domain of BaTiO_3 depend on the electric field.

537.226.2

5662. FERROELECTRIC AFTER-EFFECTS IN POLYCRYSTAL-LINE BARIUM TITANATE. W.Koch.

Z.Naturforsch., Vol. 13a, No. 4, 303-10 (April, 1958). In German.

The low-field permittivity was measured during the period immediately following application of a d.c. bias field. A sudden rise was followed by a gradual fall to a value below the initial permittivity. With very high d.c. fields the initial rise was not observed. Similar effects were found when applying a hydrostatic pressure instead of a bias field. The phenomena are explained by the splitting up of existing domains into a larger number under the influence of mechanical stresses, the new domain walls contributing to the permittivity. After some time new equilibrium positions are reached, and the lowering of the permittivity by crystal axis reorientation then overshadows the enhancing effect of domain wall movement. K.W.Plessner

537.226.2 : 537.529

TEMPERATURE DEPENDENCE OF THE BREAKDOWN FIELD OF BARIUM TITANATE. See Abstr. 4659

537.226.32

5663. SOLIDIFICATION OF PARAFFIN WAX IN AN ELECTRIC FIELD AND ITS CORRELATION TO THE ORIENTATION OBSERVED IN ELECTRETS. K.C.Chandy and D.R.Bhawaikar.

Res. Bull. Saugar Univ. Phys. Soc., Vol. 2, No. 1-2, 39-44 (1957).

Solidification of paraffin wax under high d.c. fields in two different types of apparatus was studied using X-ray diffraction techniques. Except for a few cases of slight variations of density at some regions of the circumference of the diffraction rings, no clear orientation pattern was obtained. This is contrary to the reports of Bennet and of Kakiachi. However, the result is in accord with theoretical predictions, in that the non-polar hydrocarbons in paraffin wax cannot be expected to orient in a high d.c. field. Explanations are given for the weak and random variations of density of the diffraction rings observed in some of the patterns.

537.226.32

5664. THE ANOMALOUS STABILITIES OF NEW INORGANIC POLYCRYSTALLING ELECTRETS. A.N.Gubkin and G.I.Skanavi. Zh. tekhn. Fiz., Vol. 27, No. 9, 1969-70 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 9, 1825-6 (Sept., 1957).

Previously stated conditions for storing electrets so as to maintain the charge over long periods are briefly reviewed. Electrets made from ceramic materials have been found to retain the majority of their charge without the need for short-circuiting them with metal foil. Results are given for the variation of homocharge on calcium titanate electrets stored in both the "short-circuited" and "open" conditions for a period of 8 months. The electrets had specific conductivities of 10^{-12} to $10^{-14} \text{ ohm}^{-1}\text{cm}^{-1}$, and so in the "open" condition they should have discharged completely within a few minutes.

A.E.Kay

537.226.33

5665. SOME OBSERVATIONS ON THE THEORY OF DIELECTRIC RELAXATION IN ASSOCIATED LIQUIDS. B.E.Conway. Canad. J. Chem., Vol. 37, No. 3, 613-28 (March, 1959).

The theory of absolute reaction rates is examined for the case of relaxation in associated polar liquids, where the activation process is probably an excitation of a librational motion to one of complete rotation over a rotational potential energy barrier. The rotational barriers in water are calculated using the point-charge model of the water quadrupole and the effect of thermal bond bending is examined. The experimental heats of activation for dielectric relaxation in water and deuterium oxide are discussed and their temperature dependence examined; the heat capacity change for rotational activation is derived. Isotopic effects in the heats of activation, the relaxation times, and frequency factors are discussed. A qualitative

explanation is sought for the homogeneity of relaxation times in water; rotation of water molecules in the fields of hydroxonium and hydroxide ions present in water may account for the narrow distribution of relaxation times observed experimentally. This mechanism is shown to be consistent with other theoretically derived quantities and with the mechanism of proton mobility in water. A different mechanism is indicated in ice, where the proton concentration is lower, but in ice containing extra protons, the mechanism probably reverts to that existing in water.

537.226.33

5666. ON DIELECTRIC RELAXATION IN POLAR LIQUIDS.

R.Schröder.

Z. Naturforsch., Vol. 12a, No. 9, 731-5 (1957). In German.

The complex permittivity of solutions of α -bromonaphthalene in carbon tetrachloride has been measured over the wavelength range 1 to 35 cm, at room temperature, for concentrations of 1, 5, 10 and 20% by weight. The results show some deviation from the Debye equations, especially at high concentration. Four possible explanations of the observed broadening of the dispersion region are mentioned, the one favoured being due to Fröhlich.

K.W.Plessner

537.226.8

5667. ON THE DIELECTRIC ORIENTATION POLARIZATION OF GASES. H.K.Wimmel and W.Maier.

Z. Naturforsch., Vol. 13a, No. 1, 48-9 (Jan., 1958). In German.

A quantum mechanical theory of the static dielectric constant of a gas due to molecular reorientation during collisions.

J.G.Powles

537.228.1

5668. ON THE DOUBLET SPLITTING OF RESONANCE VIBRATIONAL FREQUENCIES OF A TOURMALINE PIEZO-ELECTRIC PLATE. B.A.Finagin.

Zh. tekhn. Fiz., Vol. 27, No. 9, 2185-7 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 9, 2027-9 (Sept., 1957).

The spectrum and types of vibrations of two Z-cut circular tourmaline plates were investigated. The frequency ranges were 690 to 1580 kc/s and 670 to 1060 kc/s. The form of the vibrations was examined by the use of a Michelson interferometer. Frequencies were measured with a heterodyne wavemeter to an accuracy greater than 0.01%. The majority of resonance frequencies split into two close resonance frequencies whose separation for the different resonances varied from $\sim 0.01\%$ to $\sim 0.1\%$ of the resonance frequency. The vibrational figures for a given resonance were identical at both frequencies of a doublet but formed an angle with respect to each other around an axis normal to the centre of the plate. The two resonances of a doublet usually differ in vibrational amplitude. For resonances with vibrational figures without nodal diameters frequency splitting was not observed. Some figures and tabulated results are given.

H.G.Jerrard

537.228.4

5669. MEASUREMENT OF THE KERR EFFECT IN SOME KETONES BY AN IMPULSE PROCEDURE. G.Klages and R.Küster. Z. Naturforsch., Vol. 12a, No. 8, 629-32 (1957). In German.

The apparatus is briefly described. The results for acetone, diethyl ketone, cyclohexanone and acetophenone are discussed considering the model of the molecule as an ellipsoid made from an isotropic polarizable substance. The optical anisotropies of acetone and cyclohexanone agree well with those resulting from the use of these models, whilst that for diethyl ketone in the liquid state yields a greater anisotropy than for a gas. This latter fact can be associated with the change of form of flexible molecules in combination.

H.G.Jerrard

ELECTRIC CONDUCTION

SEMICONDUCTORS

537.311.1

5670. THE ELECTRICAL CONDUCTIVITY OF ALLOYS FORMING A MECHANICAL MIXTURE. A.É.Nikarov.

Zh. tekhn. Fiz., Vol. 27, No. 9, 2043-9 (1957). In Russian. English translation in: Soviet Physics—Technical Physics, Vol. 2, No. 9, 1892-8 (Sept., 1957).

Theoretical. It is shown that the conductivity varies linearly with composition (volume %) only if the surface separating the

components is parallel to the current. In the general case the conductivity depends on the solution of an integral equation of the second-order Fredholm type.

D.M. Edwards

537.311.1 : 539.2

THE EFFECT OF LONG AND SHORT RANGE ORDER ON RESIDUAL RESISTIVITY. See Abstr. 5133.

537.311.3

5671. THE INFLUENCE OF OXYGEN, HYDROGEN AND WATER VAPOUR ON THE ELECTRICAL CONDUCTIVITY OF BARIUM OXIDE AND BARIUM STRONTIUM OXIDE. J. Rudolph.

Z. Naturforsch., Vol. 13a, No. 9, 757-67 (Sept., 1958). In German.

Variations of the electrical conductivity σ of sintered specimens of BaO and (Ba, Sr)O with temperature T , gas pressure P and impurity ions of different valence are described and discussed. For p-type conduction in O_2 , $\sigma \sim P_{O_2}^{1/6}$ when $T > 1000^\circ K$. Monovalent alkali impurity ions increase the p-type conduction rapidly and σ was practically independent of pressure at higher values of P_{O_2} . For n-type conduction in H_2 for $T > 1000^\circ K$, $\sigma \sim P_{H_2}^{1/4}$. The conductivity increases rapidly with the presence of water vapour. The variation of electron emission with P_{H_2} was also investigated.

G.C. Williams

537.311.31 : 539.4.016.2

5672. INFLUENCE OF COLD WORK ON THE RESISTIVITY OF DILUTE COPPER ALLOYS.

R.H. Kropschot, M. Garber and F.J. Blatt.

Phys. Rev. Letters, Vol. 2, No. 3, 91-4 (Feb. 1, 1959).

Alloys of Cu with Ge, In, Sn, and Sb, containing one atomic per cent solute, all showed an increase of residual resistivity as a result of annealing after cold work. A suggested explanation is that after cold work the solute atoms are trapped at dislocation lines but are freed during anneal and scatter more effectively as independent point defects.

D.M. Edwards

537.311.31

5673. DEVIATIONS FROM MATTHIESSEN'S RULE FOR GOLD AND SILVER IN THE TEMPERATURE RANGE 10-300°K.

E. Krautz and H. Schultz.

Z. Naturforsch., Vol. 12a, No. 9, 710-14 (Sept., 1957). In German.

The deviations from Matthiessen's rule, which were predicted theoretically by Kohler (Abstr. 8732/1950), Sondheimer (Abstr. 8687/1950), Sondheimer and Wilson (Abstr. 2901/1947) are investigated in detail for Au + 1 At. % Ag and for Ag + 0.6 At. % Au. The results are discussed in relation to the two-band mechanism and also in relation to Hall effect measurements.

M.R. Hopkins

537.311.31 : 539.18

THE ISOTOPE EFFECT IN THE FLOW OF CURRENT IN MOLTEN LITHIUM METAL. See Abstr. 5099

537.311.31 : 536.212.2

INVESTIGATION OF THE WIEDEMANN-FRANZ-LORENZ LAW FOR ORDERED AND DISORDERED PHASES OF A RANGE OF COPPER-PALLADIUM ALLOYS. See Abstr. 5608

537.311.33 : 536.212

5674. APPLICATION OF THE THERMODYNAMICS OF IRREVERSIBLE PROCESSES TO CONDUCTION PHENOMENA IN SEMICONDUCTORS. W. Czaja.

Helv. phys. Acta, Vol. 32, No. 1, 1-23 (1959). In German.

The principle of minimum entropy-production in a stationary state of a system is discussed for the most general conditions. It is assumed to have an unequal number of even and odd forces, with additional conditions between these forces. Some isothermal as well as non isothermal effects are calculated: general equations governing the behaviour of the isothermal p-n junction are derived and the heat conductivity of a homogenous semiconductor under various conditions is calculated. Further applications of the theory are discussed.

537.311.33

5675. D-BAND AND MIXED-VALENCY SEMICONDUCTORS.

C. Zener.

J. Phys. Chem. Solids, Vol. 8, 26-8 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). In many cases the shell and band models predict identical or similar results. However, there are other cases where the two models make different predictions. The present paper discusses the relevant theoretical and experimental information which is of aid in deciding on the most appropriate model.

5676. EFFECTS OF COULOMB FORCES ON THE CONDUCTION PROPERTIES OF SEMI-CONDUCTORS. S. Doniach.

Rep. Brit. Elect. Res. Assoc., Rep. L/T368, 37 pp. (1957).

Present day theory of the electrical properties of semiconductors disregards, for the most part, the powerful Coulomb forces acting between the current carriers in these conductors. In this report possible effects of these Coulomb forces on conduction properties are considered. A dynamic treatment of the screening of moving charge distributions by a non-degenerate gas of free (or conduction) electrons is proposed, making possible the calculation effects of the Coulomb forces on the mechanism of scattering of conduction electrons by lattice vibrations and impurity ions. The treatment demonstrates that only virtual excitations of plasma oscillations of the electron gas are involved in the screening, so that no short distance cut-off is required. This can be carried through quantum-mechanically, and it is shown that statistical fluctuation in the density of the gas, which would lead to the damping of real plasma oscillations, now causes the scattering of some of the electrons on the screened charges. The mean free path for conduction electrons in a semiconductor is shown to be influenced by the effects of the Coulomb forces in two ways — through the screening of the lattice vibrations and the impurity ions, and through the inter-electronic screening, leading to density dependent inertial effects. The conduction properties of semiconducting samples of the germanium-silicon type, with conduction electron concentration of less than $\sim 10^{18} \text{ cm}^{-3}$ at normal temperatures ($\sim 300^\circ \text{ abs}$), are not so much affected by these considerations, but it is possible that the Coulomb forces may play a significant role in the mechanism of conduction in polar semiconductors.

537.311.33 : 538.615 : 535.337

5677. ZEEMAN TYPE MAGNETO-OPTIC STUDIES OF ENERGY BAND STRUCTURE.

E. Burstein, G.S. Picus, R.F. Wallis and F. Blatt.

J. Phys. Chem. Solids, Vol. 8, 395-11 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The energy levels associated with an energy band in a magnetic field are characterized by the following quantum numbers: $\hbar k_H$, the crystal momentum along the magnetic field direction; l , the Landau magnetic quantum number; and M_J , the component of the total angular momentum along the magnetic field which is characteristic of the atomic states in the tight binding limit. In the case of degenerate valence bands, the effect of a magnetic field is complicated by degeneracy effects and the levels in a magnetic field are characterized by two or more pairs of (l , M_J) values. The selection rules, polarization effects, and the character of the absorption spectra of interband transitions in a magnetic field are discussed and illustrated by experimental data for Ge. The physics underlying the Zeeman type interband magneto-optic (IMO) effects in semiconductors is discussed.

537.311.33

5678. USE OF EFFECTIVE MASS AND NORMAL ELECTRONIC MASS IN SEMICONDUCTORS. D. Curie.

J. Phys. Radium, Vol. 19, No. 8-9, 694-703 (Aug.-Sept., 1958). In French.

Friedel has suggested that in some cases an impurity level may be better described by a Wannier-type equation using the free electron mass than by the usual Wannier equation using the effective mass (see Abstr. 3730/1955). This is perhaps the case for electron traps in sulphide phosphors. Such a procedure is valid for some deep levels, when, in the development of the wave-function of the impurity level into series of Bloch functions, high-energy terms only appear: these terms may be associated with almost free electrons in the conduction band. On the other hand, shallow donors in Ge and Si are described by a development using only low-energy Bloch functions: thus the effective electron mass at the bottom of the conduction band must be introduced into the Wannier equation. The one-dimensional Kronig-Penney lattice model is studied as an example.

537.311.33

5679. HOT AND WARM ELECTRONS — A REVIEW.

S.H. Koenig.

J. Phys. Chem. Solids, Vol. 8, 227-34 (Jan., 1959).

Rochester Semiconductors Conference Paper (See Abstr. 4569/1959). There are two categories of problems relating to the study of hot and warm carriers (i.e. the situation in which the mean carrier kinetic energy deviates measurably from its equilibrium thermal value). The first of these relates to the manner in which a

steady state distribution is maintained. The pertinent work to date, both experimental and theoretical, is reviewed. The second set of problems involves the phenomena which result from a non-equilibrium distribution, but that do not play a significant role in determining it. The velocity dependence of recombination cross sections, impact ionization of neutral impurities and enhanced thermionic emission are among these. The present experimental situation is discussed and related to what relevant theory exists for the various cases.

537.311.33

5680. MOTION OF ELECTRONS AND HOLES IN SEMICONDUCTORS FROM A MANY-ELECTRON POINT OF VIEW.

W. Kohn.

J. Phys. Chem. Solids, Vol. 8, 45-7 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The physical properties of a conduction electron or hole in a semiconductor are customarily interpreted in terms of a model in which they are regarded much like free electrons or positrons, using an effective electron mass and a modified Coulomb interaction. It is shown that this model can be strictly derived from the many-electron Schrödinger equation, provided only that the interaction of the carrier with the field produced by the embedded charge is weak enough. The effects of the electron-electron interaction are summed to all orders of perturbation theory, using the techniques of Feynman and Goldstone. This result constitutes one of the simplest cases of a (finite) mass and charge renormalization.

537.311.33

5681. THEORETICAL TRANSPORT COEFFICIENTS FOR POLAR SEMICONDUCTORS. R.T. Delves.

Proc. Phys. Soc., Vol. 73, Pt 4, 572-6 (April, 1959).

The mobility, thermoelectric power and weak field Hall coefficient are calculated when the charge carriers of a polar semiconductor are scattered by an optical mode of vibration of the lattice. The collision operator derived by Fröhlich, and Howarth and Sondheimer was used, and the Boltzmann transport equation was integrated directly on an electronic computer. Results are given for $2\theta \geq T \geq \theta/2$ and $5 \geq \eta \geq -2$. (η is the reduced Fermi level, $\theta = \nu_1 h/k$, and ν_1 is the frequency of the longitudinal optical mode.) These results are compared where possible with those obtained from a different method of calculation by Howarth, Lewis and Sondheimer. Rough values are also given for the Lorenz number and weak field Ettingshausen coefficient.

537.311.33

5682. ON THE PROBLEM OF RELAXATION OF NON-EQUILIBRIUM CONDUCTIVITY ON RECOMBINATION AT TRAPS.

S.M. Ryvkin and N.B. Strokan.

Dokl. Akad. Nauk SSSR, Vol. 124, No. 5, 1034-7 (1959). In Russian.

This is an extension of Shockley and Read's work (Abstr. 8183/1952) on non-equilibrium conductivity in semiconductors when recombination occurs at neutral or singly charged traps. The authors show that the experimental data confirm the theoretical prediction that the density of non-equilibrium charge carriers depends non-linearly on the intensity of light which produces them, and that photoconductivity relaxes non-exponentially.

A. Tybulewicz

5683. VOLUME AND SURFACE RECOMBINATION OF INJECTED CARRIERS IN CYLINDRICAL SEMICONDUCTOR INGOTS.

J.P. McKelvey.

I.R.E. Trans Electron Devices, Vol. ED-5, No. 4, 260-4 (Oct., 1958).

An exact solution to the diffusion-recombination problem is obtained for the case of a sample in the form of a right circular cylinder with arbitrary bulk lifetime, arbitrary surface recombination velocity on the lateral curved surface of the sample, and infinite surface recombination velocity on the (lapped) plane end surfaces of the sample. The latter surfaces may be regarded as electrical contacts to the sample, and in such a case the geometry corresponds precisely to a very commonly used experimental arrangement for recombination measurements. Relations between bulk lifetime, surface recombination velocity and observed time constant are calculated and plotted with the height-radius ratio of the cylinder as parameter for the principal decay mode, and the higher-mode decay scheme is worked out for a few cases of practical interest. Examples of simultaneous surface recombination and bulk lifetime measurement by observation of the higher-mode decay components are presented.

537.311.33 : 621.315.59

537.311.33

5684. FIELD EFFECT AT HIGH FREQUENCY. F. Berz.

J. Electronics and Control, Vol. 6, No. 2, 97-112 (Feb., 1959).

A theory is developed using the same basic assumptions as Garrett (1957), with more complete conditions at the back surface. The charges induced in the front surface layer are given as the sums of two terms, of which one depends on the surface properties only, and the other is proportional to the modulation of the carrier density at the boundary between the surface layer and the bulk, which depends on the filament lifetime. The results are illustrated in detail by a numerical example.

537.311.33

5685. GIANT TRAPS. M. Lax.

J. Phys. Chem. Solids, Vol. 8, 66-73 (Jan., 1959).

Rochester Semiconductors Conference Paper (Abstr. 4569/1959). Enormous cross-sections in the range from 10^{-15} to 10^{-13} cm² were observed for a wide variety of traps in Si and Ge some involving binding energies many times the Debye energy. Direct transitions to the ground states of these traps require simultaneous emission of many phonons. Such multiphonon emission is a highly unlikely event in these materials where the electron-lattice interaction is weak and yields cross-sections too small by five to ten orders of magnitude. Cross-sections comparable to, or within an order of magnitude of those observed can be calculated on the basis of capture into the highly excited states of coulomb attractive centres followed by a cascade process involving successive emissions and absorptions of single phonons until the electron enters the ground state or escapes. The initial capturing event is likely to involve an optical phonon or an intervalley collision in the room temperature range, but the acoustic phonon contribution will predominate at low temperatures. The large cross-sections from 10^{-17} to 10^{-15} cm² found for neutral centres can be explained on the same basis, the attractive potential in this case being provided by the large polarizability of the neutral centre.

537.311.33

5686. THE ELECTRICAL STRUCTURE OF SEMICONDUCTOR SURFACES. A. Many.

J. Phys. Chem. Solids, Vol. 8, 87-96 (Jan., 1959).

Rochester Semiconductors Conference Paper (Abstr. 4569/1959). The present status of semiconductor surface research is briefly reviewed. The properties of the space-charge region, the oxide layer normally present on a real surface, and the slow and fast states are considered. Various measurements, such as those of field effect over a wide frequency range and surface recombination velocity are discussed. The energy distribution and hole and electron capture cross-sections of the fast states in germanium and silicon, as deduced from such measurements by various workers, are then summarized. The good experimental agreement among workers in this field as to the general characteristics of the fast states is particularly significant in view of the widely different treatments given to the surface in the different laboratories. Although the information available on the surface states is appreciable, particularly on germanium, the important question of their origin is still largely open. Some implications of the meagre available data bearing on this problem is discussed.

537.311.33

5687. A METHOD FOR MEASURING THE RATE OF SURFACE RECOMBINATION IN ACCORDANCE WITH THE VARIATION OF THE RESISTANCE OF A SEMICONDUCTOR IN A MAGNETIC FIELD. V.P. Zhuze, G.E. Pikus and O.V. Sorokin.

Zh. tekhn. Fiz., Vol. 27, No. 6, 1167-73 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 6, 1061-7 (June, 1957).

In thin semiconductor specimens whose thickness is comparable to the diffusion length it is possible to observe anomalous phenomena which are associated with the deviation of the current-carrier concentration from the equilibrium value. In particular, if the surface of such a specimen is so treated that the recombination rates s_1 and s_2 on the faces are not identical, then the expression for the variation of the resistance of this specimen in a magnetic field H contains two terms: one proportional to H^2 , and the second linearly dependent upon the field. This effect was used as a basis for the measurement of the surface recombination rate. The results obtained were in good agreement with those predicted theoretically.

5688. MAGNETIC SUSCEPTIBILITY OF FOREIGN ATOMS IN SEMICONDUCTORS — THEORETICAL CONSIDERATIONS. D.Geist.
Z. Naturforsch., Vol. 12a, No. 11, 873-6 (1957). In German.
Impurity atoms with several energy levels are considered and a detailed discussion for the case of two electrons in s states (with a numerical example) is given. R.Stratton
537.311.33 : 538.2
5689. THE BEHAVIOUR OF SOME IMPURITIES IN III-V COMPOUNDS. J.T.Edmond.
Proc. Phys. Soc., Vol. 73, Pt 4, 622-7 (April, 1959).
Some aspects of the behaviour of group II, IV and VI elements as impurities in InSb, InAs, GaSb and GaAs have been studied. It is of particular interest to know whether these behave as donors or acceptors. In some cases, which are discussed, e.g. magnesium in GaAs, abnormal behaviour is observed.
537.311.33
5690. THE DOPING OF $A^{III}B^V$ COMPOUNDS WITH ELEMENTS IN THE FOURTH GROUP OF THE PERIODIC SYSTEM. O.G.Folberth and E.Schillmann.
Z. Naturforsch., Vol. 12a, No. 11, 943-4 (1957). In German.
Describes measurements of the Hall effect on specimens of GaSb, InSb, InAs and InP doped with Ge and Sn. (Attempts to dope with Pb failed). The type of conduction found agrees well with the theory of Welker (Abstr. 3298/1953), that the ions tend to replace the larger ion in the compound if the impurity ion is large. J.M.Hough
537.311.33
5691. ON THE INFLUENCE OF THE POLARIZATION ON THE SEMICONDUCTING PROPERTIES OF $A^{III}B^V$ COMPOUNDS. O.G.Folberth.
Z. Naturforsch., Vol. 13a, No. 10, 856-65 (Oct., 1958). In German.
The valence electrons in $A^{III}B^V$ compounds are, on the average, displaced from the centre of the tetrahedral bonds in the direction of the B^{++} ions. The variation among isoelectronic compounds of the forbidden gap width, the electron mobility, the electron-hole mobility ratio and various alloying properties can be correlated with the degree of this polarization. R.Stratton
537.311.33
5692. INVESTIGATION OF THE INTERMETALLIC COMPOUND Bi_2Te_3 AS WELL AS THE SOLID SOLUTIONS $Bi_{2-x}Sb_xTe_3$ AND $Bi_2Te_{3-x}Se_x$ IN VIEW OF THEIR SUITABILITY AS MATERIALS FOR SEMICONDUCTOR THERMO-ELEMENTS. U.Birkholz.
Z. Naturforsch., Vol. 13a, No. 9, 780-92 (Sept., 1958). In German.
The electrical conductivity, thermal conductivity, thermoelectric power and Hall coefficient were measured at a temperature of 300°K on samples produced by the Bridgeman method. The best (i.e. highest figure of merit for thermoelectric generation or refrigeration) p-type semiconductor was the alloy $Bi_{0.6}Sb_{0.4}Te_3$ while suitably doped n-type Bi_2Te_3 was better than any of the $Bi_2Te_{3-x}Se_x$ alloys. The figure of merit z for a thermocouple constructed from these two materials is $2.1 \times 10^{-3} \text{ deg}^{-1}$ leading to a theoretical maximum cooling of 80°C which was verified by experiment. Some experiments on sintered samples are also discussed. R.Stratton
537.311.33
5693. CONTACT FREE EXCITATION OF ELECTRONS IN CdS SINGLE CRYSTALS. K.W.Böer and U.Kümmel.
Z. Naturforsch., Vol. 13a, No. 8, 698-9 (Aug., 1958). In German.
Extension of earlier work (Abstr. 9638/1955) to eliminate injection of carriers by interposing an insulator between the metal contacts and the semiconductor. Results are consistent with direct excitation of electrons from bound to conduction state and recombination. G.C.Williams
537.311.33
5694. ELECTROSTATIC CHARGE ON CdS SINGLE CRYSTALS UNDER THE INFLUENCE OF HIGH FIELDS. K.W.Böer and U.Kümmel.
Z. Naturforsch., Vol. 12a, No. 8, 667-8 (1957). In German.
The work of Smith and Rose (Abstr. 4646/1955) is extended: the dependence of the measured induced charge Q on the frequency and the magnitude of the applied field, in particular, is discussed. Q was found to be independent of the contact material. The results are discussed in relation to the theory proposed by Smith and Rose. G.C.Williams
537.311.33
5695. MEASUREMENTS OF THE CONTACT POTENTIAL DIFFERENCE ON CADMIUM SULPHIDE. W.Schaaffs and H.Woelk.
Z. angew. Phys., Vol. 10, No. 10, 456-8 (Oct., 1958). In German.
Reports results for the variation of contact p.d. between gold and cadmium sulphide when the latter is illuminated by white light of varying intensity. R.Stratton
537.311.33
5696. THEORETICAL SURFACE CONDUCTIVITY CHANGES AND SPACE CHARGE IN GERMANIUM AND SILICON. V.O.Mowery.
J. appl. Phys., Vol. 29, No. 12, 1753-7 (Dec., 1958).
Graphs are presented displaying predicted surface conductivity changes as a function of resistivity for various values of surface potential, and space charge as a function of resistivity for the same range of surface potential, in germanium and silicon. The curves display the trends of the two properties over wide resistivity ranges and are particularly convenient for obtaining theoretical field effect curves. A brief discussion of values for the electrical properties of germanium and silicon is included.
537.311.33
5697. EFFECT OF VARIOUS ETCHES ON RECOMBINATION CENTERS AT GERMANIUM SURFACES. G.Wallis and S.Wang.
J. Electrochem. Soc., Vol. 106, No. 3, 231-8 (March, 1959).
Germanium samples were etched with CP-4, hydrogen peroxide, iodine A, electrolytic, and silver etch. The density, energy levels, and capture probabilities of the recombination centres were measured before and after the etched samples were baked. It was found that iodine A and electrolytic etches produce recombination centres of one type, and the remaining etches, centres of another type. Baking converted the centres found on iodine A etched surfaces into the type of centres that are characteristic of surfaces etched with CP-4, hydrogen peroxide, and silver etches. When surfaces were prepared with an etch other than iodine A, baking increased the density but did not affect the types of the centres. The different etches did not produce significant differences in maximum surface recombination velocity either before or after baking.
537.311.33
5698. STUDIES ON THE RECOMBINATION OF ELECTRONS AND HOLES IN GERMANIUM. S.G.Kalashnikov.
J. Phys. Chem. Solids, Vol. 8, 52-9 (Jan., 1959).
Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The lifetime of nonequilibrium charge carriers in n- and p-type germanium was measured as a function of the equilibrium carrier concentrations. The concentration range from the intrinsic region up to $\sim 10^{18} \text{ cm}^{-3}$ was covered. Both electron and hole capture coefficients were found to be independent of concentration up to the concentrations of at least $\sim 10^{17} \text{ cm}^{-3}$. The temperature dependence of the hole lifetimes in copper-doped n-type germanium was investigated. The experimental data were compared with the statistics of recombination on many-level centres and a good agreement was obtained. From the data, some conclusions were drawn on the nature of elementary capture processes in germanium.
537.311.33
5699. THE EFFECT OF PRESSURE ON THE PROPERTIES OF GERMANIUM AND SILICON. W.Paul.
J. Phys. Chem. Solids, Vol. 8, 196-204 (Jan., 1959).
Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Measurements of the pressure dependence of the intrinsic resistivity, the fundamental absorption edge, the carrier mobilities, the magnetoresistance coefficients, and the dielectric constant are reviewed, and an explanation based on the shift of the band edges is presented. Experimental evidence for similar behaviour of corresponding band extrema in germanium, silicon and the intermetallics is given. The cases of the (111) and (100) minima in germanium and silicon and the Ge-Si alloys are discussed in detail. The results of measurements of the change of ionization energy of shallow and deep lying impurity levels in germanium and silicon are also reviewed.
537.311.33
5700. ON PHOTO-IONIZATION BY FAST ELECTRONS IN GERMANIUM AND SILICON. V.S.Vavilov.
J. Phys. Chem. Solids, Vol. 8, 223-6 (Jan., 1959).
Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Experimental results are presented on the quantum yield at photon energies high compared with the energy gap, and on ionization by fast electrons.

5701. **ANISOTROPY OF HOT ELECTRONS IN GERMANIUM.** W.Sasaki, M.Shibuya, K.Mizuguchi and G.M.Hatoyama. *J. Phys. Chem. Solids*, Vol. 8, 250-6 (Jan., 1959).
Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). An electromotive force perpendicular to the current flowing in n- and p-type germanium samples is observed. The angle of deviation of the electric field vector from the current vector is a function of field strength, temperature, and current orientation, and exceeds 20° in some cases. This anisotropy of electric conduction can be attributed to the anisotropy of the energy surfaces of the conduction and valence bands of germanium. 537.311.33
5702. **ALPHA-PARTICLE IRRADIATION OF Ge AT 4.2°K .** G.W.Gobeli. *Phys. Rev.*, Vol. 112, No. 3, 732-9 (Nov. 1, 1958).
Degenerate n- and p-type germanium samples were irradiated at 4.2°K with polonium alpha-particles. The irradiation removed carriers at a rate of 2.84×10^4 electrons/ α -cm in n-type samples and 1.32×10^4 holes/ α -cm in p-type samples. Thermal recovery was studied up to 78°K . No measurable recovery was observed below 22°K . Upon warming to 78°K the irradiation-induced changes of Hall coefficient decreased by about the same fraction, 25% and 22%, respectively, in n-type and p-type samples, showing that the same fractions of donor and acceptor defects were annealed out. Experiments made with various annealing procedures, using electrical resistivity as a measure, indicated that there were two distinct regions of thermal recovery, with maximum rates of change occurring near 33°K and 67°K . The low-temperature process appears to follow a first-order reaction with a unique activation energy of about 0.02 eV. It may be due to the recombination of interstitials with nearby vacancies. The higher temperature process does not yield to simple analysis. 537.311.33
5703. **ENERGY LEVELS IN IRRADIATED GERMANIUM.** E.I.Blount. *Phys. Rev.*, Vol. 113, No. 4, 995-8 (Feb. 15, 1959).
The energy levels found in germanium irradiated by different particles seem at first to be mutually inconsistent. It is possible tentatively to reconcile the differences by consideration of clustering and association of defects. Four levels are ascribed to single vacancies and interstitials. A crude theory is constructed to explain these levels, particularly their asymmetrical distribution in the energy gap, and to assign each to a definite defect. This theory differs somewhat from a previous one due to James and Lark-Horovitz (Abstr.1780/1952); some differences in experimental predictions are discussed in particular. 537.311.33
5704. **EFFECT OF MINORITY IMPURITIES ON IMPURITY CONDUCTION IN P-TYPE GERMANIUM.** H.Fritzsche and K.Lark-Horovitz. *Phys. Rev.*, Vol. 113, No. 4, 999-1001 (Feb. 15, 1959).
Hall coefficient R and resistivity ρ of various p-type germanium samples which contained the same concentration of acceptors N_A but different amounts of compensating donors N_D were measured between 300° and 1.3°K . The process of impurity conduction at low impurity concentrations differs from that at high concentrations in that it requires the presence of empty majority centres. As in the case of n-type Ge, the two different impurity conduction processes could be distinguished by observing the change of ρ resulting from a change in the degree of compensation in the temperature range of impurity conduction. At large impurity concentrations ($N_A = 2.4 \times 10^{17}/\text{cm}^3$) the resistivity is independent of temperature only if the concentration of mobile carriers is sufficiently large. The resistivity increases with a finite activation energy in strongly compensated samples. 537.311.33 : 621.315.59
5705. **EXPERIMENTAL DETERMINATION OF ELECTRON TEMPERATURE IN HIGH ELECTRIC FIELDS APPLIED TO GERMANIUM.** E.G.S.Paige. *Proc. Phys. Soc.*, Vol. 72, Pt 5, 921-3 (Nov., 1958).
The electron temperature is deduced from the field dependence of drift velocity for an n-type specimen in strained and unstrained states. With the specimen at 77°K the electron temperature becomes appreciably greater than the lattice temperature at a field of 220 volts/cm, and reaches over 600°K at 1 kV/cm. The experimental results are compared with theoretical predictions. C.Hilsum
5706. **NOISE OF Ge MONOCRYSTALS.** D.Sautter and K.Seiler. *Z. Naturforsch.*, Vol. 12a, No. 6, 490-7 (1957). In German.
Presents the results of measurements of the noise of Ge monocrystals for various values of field intensity, temperature (20 - 140°C), frequency (2 - 150 kc/s) and doping (specific resistances between 0.3 and 60 ohm-cm at room temperature, both p and n conductivity). The mean square of noise current i_n^2 increases according to a square law with the field intensity; its dependence on frequency f is roughly $i_n^2 \sim 1/[1 + (2\pi f\tau)^2]$, and it increases roughly exponentially with temperature, these two last relationships depending on doping. F.Lachman 537.311.33 : 621.382
5707. **THE INFLUENCE OF THE GAS ATMOSPHERE ON THE SURFACE RECOMBINATION OF GERMANIUM.** G.Adam. *Z. Naturforsch.*, Vol. 12a, No. 7, 574-82 (1957). In German.
Variations in the surface recombination velocities of n- and p-type germanium, when specimens were exposed to a number of gases containing and free from water vapour, were determined by a moving light spot method. The experimental results are discussed in relation to the Brattain-Bardeen model of the surface and the Shockley-Read theory of recombination. G.C.Williams 537.311.33
- STUDIES OF DEUTERON-IRRADIATED GERMANIUM. See Abstr. 5170-2 537.311.33 : 539.21
- ABSORPTION SPECTRA OF GROUP V DONORS IN GERMANIUM. See Abstr. 5534 537.311.33 : 535.343
- INFRARED ABSORPTION BY CONDUCTION ELECTRONS IN GERMANIUM. See Abstr. 5543 537.311.33 : 535.345
5708. **THE FORM OF THE CONDUCTIVITY BAND OF INDIUM ARSENIDE.** D.Geist. *Z. Naturforsch.*, Vol. 13a, No. 8, 699-700 (Aug., 1958). In German.
Compares measured and theoretical values of magnetic volume susceptibility of electrons in indium arsenide for a range of electron concentrations from $3 \times 10^{16} \text{ cm}^{-3}$ to $3 \times 10^{18} \text{ cm}^{-3}$. G.C.Williams 537.311.33 : 539.2
- EFFECTIVE MASS OF ELECTRONS IN THE INTRINSIC REGION OF InSb. See Abstr. 5139 537.311.33 : 538.221
- SUSCEPTIBILITY OF PbTe. See Abstr. 4781 537.311.33 : 538.221
- SUSCEPTIBILITY OF SELENIDES AND TELLURIDES OF HEAVY ELEMENTS. See Abstr. 4782 537.311.33 : 537.533
- ELECTRON EMISSION FROM BREAKDOWN REGIONS IN SiC P-N JUNCTIONS. See Abstr. 4678 537.311.33 : 536.212
5709. **THE SEMICONDUCTING COMPOUND SiTe .** K.Šmirnov, L.Štourač and J.Bednář. *Czech. J. Phys.*, Vol. 7, No. 1, 120-22 (1957). In German.
Polycrystalline p-type samples, grown from stoichiometric proportions of Si and Te, had a melting point of 898°C and a density of 3.93 g/cm^3 . Electrical conductivities of about $5 \times 10^{-3} \text{ ohm}^{-1} \text{ cm}^{-1}$ and thermal conductivities of about $1.5 \times 10^{-3} \text{ cal deg}^{-1} \text{ cm}^{-1} \text{ sec}^{-1}$ were measured at room temperature. R.Stratton 537.311.33 : 539.232
- PREPARATION OF TRANSPARENT SEMICONDUCTOR LAYERS ON GLASS BY THE HYDROLYSIS OF ACTIVATED SnCl_4 . See Abstr. 5185 537.311.33
5710. **ELECTRICAL CONDUCTION IN CRYSTALS AND CERAMICS OF WO_3 .** S.Sawada and G.C.Danielson. *Phys. Rev.*, Vol. 113, No. 3, 803-5 (Feb. 1, 1959).
The specific resistivities of crystals and ceramics of WO_3 were measured from room temperature to 1000°C , and the sign and order

of magnitude of the Hall coefficient was examined near room temperature. From the results for single crystals, it was found that WO_3 behaves like an impurity semiconductor having a saturation region below 740°C and becoming intrinsic above 910°C . The specific resistivity v. temperature curve had an anomaly at 740°C suggesting an alteration in the electronic structure at this temperature. Below 740°C , the specific resistivity of ceramic samples showed a remarkable hysteresis phenomenon, probably arising from a cracking of crystallites on heating. The sign of the Hall coefficient was positive at room temperature and its magnitude gave reasonable values for the number and mobility of the carriers. Nonohmic and rectifying characteristics were observed by means of an oscilloscope.

537.311.33

5711. ELECTRONIC PROPERTIES OF ZnO . A.R.Hutson.

J. Phys. Chem. Solids, Vol. 8, 467-72 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Hall effect measurements on doped, n-type single-crystals of ZnO have yielded: a density-of-states mass of 0.5m, a shallow donor ionization energy of 0.05 eV, and the temperature dependence of mobility. An effective mass of 0.27m is derived from the donor binding energy. It is used in the computation of the optical-mode scattering, which together with some acoustical-mode scattering, fits the mobility data. Thermoelectric power measurements show the presence of a large phonon-drag (Q_p) contribution. The Q_p saturation effect yields an effective inertial mass of 0.07m, and it is shown that it is approximately isotropic. Magnetoresistance measurements show that there must be at least 12 valleys in the ZnO conduction band and that the valleys are not greatly anisotropic. The small inertial mass is compatible with the density-of-states mass and the 12 valleys of small anisotropy; however, the donor binding energy and the optical-mode scattering both seem to require an effective mass larger by a factor of 4. A tentative model is suggested which might resolve this difficulty.

537.311.33 : 621.382

5712. EXPERIMENTAL INVESTIGATIONS OF THE INFLUENCE AND THE PRODUCTION OF LATTICE DEFECTS IN JUNCTION TRANSISTORS. E.Baldinger, H.Bilger and M.A.Nicolet.

Helv. phys. Acta, Vol. 32, No. 1, 78-88 (1959). In German.

It is shown for Si transistors that the influence of lattice defects can be recognized in the behaviour of the static collector potential $V_0 = V_{ec}(I_c)I_c = 0$ and of the current transmission factor $\alpha = (I_c/I_e)V_{cb} = 0$ below 150°C . The same effects are also present in Ge transistors at sufficiently low temperatures (about 0°C). As a check the number of lattice defects was raised by fast neutron radiation until their influence became measurable at room temperature. The measurements can be interpreted when the results of the theory of Sah et al (Abstr. 178/1958) are suitably introduced into Shockley's model of junction transistors. On the other hand, thermal neutrons create essentially only such changes in the characteristics which are explainable by the Shockley model alone. The influence of fast and thermal neutron radiation on some differential parameters and on the noise of Ge transistors was also investigated. The results correspond to the expectations. Further, these experiments with fast neutrons support the theory that low frequency noise is mainly due to surface effects.

537.311.33 : 537.533.92 : 621.382

5713. CURRENT AMPLIFICATION BY ELECTRON BOMBARDMENT IN THE SEMICONDUCTOR BARRIER LAYER.

K.Takeya and K.Nakamura.

J. Phys. Soc. Japan, Vol. 13, No. 2, 223 (Feb., 1958).

Se photocells and Ge and Si junctions were bombarded with electrons, and the multiplication — the ratio of current produced to the bombarding current — measured as a function of the reverse bias and the bombarding energy. Multiplications of over 1000 were obtained for all three materials.

C.Hilsum

537.311.33 : 537.529

5714. BREAKDOWN IN SILICON PN JUNCTIONS. J.Shields.

J. Electronics and Control, Vol. 6, No. 2, 130-48 (Feb., 1959).

Some useful empirical relationships on the variation of effective ionization coefficients associated with the avalanche breakdown phenomena are derived from measurements on silicon alloy junctions, in the range of impurity concentrations of the basic material from 5×10^{13} to 10^{18} per cm^3 . These results show that, for electric field strengths from 1.5×10^5 to 3×10^5 V/cm, the effective ionization coefficient is $18E^7$; from 3×10^5 to 6×10^5 V/cm, it is of the form

$$2.7 \times 10^5 \exp(-6.45/E);$$

and for values greater than 6×10^5 V/cm, it tends to $E \times 10^5/5$, where in all cases E is measured in units of 10^5 V/cm. Some discussion is given on the compatibility of calculations of ionization coefficients derived from breakdown measurements and those from multiplication measurements.

537.311.33

5715. THE EFFECTIVE EMITTER AREA OF POWER TRANSISTORS. R.Emeis and A.Herlet.

Z. Naturforsch., Vol. 12a, No. 12, 1016-18 (1957). In German.

Considers the loss of injection in the middle of a circular emitter due to the radial potential drop caused by the radial flow of majority carrier current in the base region to the bulk recombination centres there. The effect is shown to be negligible if the emitter radius is small compared with the bulk diffusion distance for minority carriers in the base region; for the converse situation the effective emitter area is a ring extending inwards from the periphery of the real emitter by $2^{1/2}$ times the bulk diffusion distance. Experimental results support the prediction. A concentric ring structure for emitter and base electrodes gives improved performance for a 20 amp silicon transistor.

F.F.Roberts

537.311.33

5716. THE REVERSE VOLTAGE LIMITS OF ALLOY TYPE SILICON POWER TRANSISTORS. R.Emeis and A.Herlet.

Z. Naturforsch., Vol. 12a, No. 12, 1018-19 (1957). In German.

Presents experimental data on the avalanche breakdown and punch-through voltages as a function of base-region resistivity and thickness, for n-p-n devices. The avalanche voltage can be expressed as $40 \rho^{3/4}$ where ρ is the base-region resistivity in ohm-cm. The output characteristics of the transistor at high currents and low voltages are shown to be independent of the base-region resistivity as between 9 and 1500 ohm-cm, for fixed base thickness, as expected by analogy with power diodes at forward bias.

F.F.Roberts

537.311.33 : 621.382

5717. THE EFFECT OF THE BULK RESISTANCE OF THE SEMICONDUCTOR ON THE FORM OF THE CURRENT-VOLTAGE CHARACTERISTIC OF A DIODE. V.I.Stafeev.

Zh. tekh. Fiz., Vol. 28, No. 8, 1631-41 (1958). In Russian.

Calculations were made applicable to alloy diodes with recombination in the bulk and infinite recombination velocity at the second contact; approximations valid at high and low injection levels are given. At low levels the bulk gives an apparently ohmic drop; however, the apparent resistance is different from the true resistance. At high levels $I = I_c \exp(qV/c kT)$, where I_c and c are functions of the base thickness divided by the diffusion length. Experimental results obtained on Ge diodes of various base thicknesses were analysed consistently in terms of the theory to give the operative diffusion lengths. The theory also predicts that for voltages $> V_0$ (where $V_0 \sim$ forbidden gap) the current should decrease with increase of temperature for alloy diodes on extrinsic material, whereas it would always increase for intrinsic material.

K.F.Hulme

537.312.5 : 535.343

5718. OPTICAL INVESTIGATION OF SEMICONDUCTORS AT THE UNIVERSITY OF ROCHESTER. D.L.Dexter.

J. Phys. Chem. Solids, Vol. 8, 473-81 (Jan., 1959).

Rochester Semiconductors Conference Paper (Abstr. 4569/1959). A survey is given of recent investigations at this institution of optical properties of non-metals. The fundamental absorption of the alkali, silver, and thallous halides and of cadmium sulphide; intrinsic photoconductivity in the alkali halides; electron multiplication in lead sulphide and selenide; and the theory of excitons in the tight binding approximation are among the topics discussed.

537.312.5 : 771.534.3

5719. ENERGY TRANSFERS BETWEEN CRYSTALS AND ADSORBED DYES. II. EFFECT OF CONCENTRATION ON EFFICIENCY OF SENSITIZATION. R.C.Nelson.

J. Opt. Soc. Amer., Vol. 48, No. 12, 948-52 (Dec., 1958).

For Pt I, see Abstr. 2726 (1958). The effect of density of sensitizer molecules adsorbed on a cadmium sulphide surface on the efficiency of sensitization by them has been studied for malachite green, pinacyanole, erythrosin, and 3,3'-diethylthiocarbocyanine. The losses in the case of the first two are drastic and can be accounted for directly in terms of the properties of the solid dyes. The detailed process of electron transfer from a dye molecule or aggregate to a crystal substrate is considered briefly. It is concluded that there should in general be a loss of efficiency in passing from

the state in which molecules are adsorbed singly and broadside, to that in which they are adsorbed as a close-packed aggregate.

5720. PHOTOCONDUCTOR PERFORMANCE, SPACE-CHARGE CURRENTS, AND THE STEADY-STATE FERMİ LEVEL.

A. Rose and M. A. Lampert.

Phys. Rev., Vol. 113, No. 5, 1227-35 (March 1, 1959).

The performance of a photoconductor is analysed, using the concept of the steady-state Fermi level, and shown to be limited by the injection of space charge. Using the gain-bandwidth product G/τ_0 as a measure of performance, it is found that $G/\tau_0 = M/\tau_r$, where τ_r is the dielectric relaxation time under operating conditions, and $M = N_A/N_T$, with eN_A the total charge on the anode and eN_T the total volume charge, free plus trapped, effectively in thermal contact with the free charge. Generally, $M > 1$ is achieved only concomitantly with space-charge-limited currents varying steeply with voltage. An important exception is the case where recombination centres control the onset of injected space charge.

5721. TEST EQUIPMENT FOR PHOTOCONDUCTORS.

R. Gereth and H. A. Muser.

Z. angew. Phys., Vol. 10, No. 9, 419-24 (Sept., 1958). In German.

Describes in detail test equipment for measuring such characteristics as spectral response, noise figure, sensitivity, and time constant of photoconductive devices.

C. A. Hogarth

5722. ON THE TEMPERATURE DEPENDENCE OF THE DARK-CURRENT CONDUCTIVITY OF ORGANIC DYES.

H. Meier.

Z. phys. Chem. (Leipzig), Vol. 208, No. 5-6, 325-39 (April, 1958).

In German.

The dark current of photoconductive films of dyes increases with temperature $\propto \exp(-\Delta E/2kT)$, similar to the dark current behaviour found in a number of organic compounds. For a band model of the conduction process in dyes, the activation energy ΔE corresponds to transitions between the highest filled band and excitation level. It is shown that the electron gas model applied by Eley and Parfitt (Trans Faraday Soc., Vol. 51, Pt 11, 1529-39, Nov., 1955) to the conduction in organic compounds is also applicable to dyes.

F. Ansbacher

5723. ON THE INFLUENCE OF TEMPERATURE ON THE PHOTOELECTRIC CONDUCTIVITY OF ORGANIC DYES.

H. Meier.

Z. phys. Chem. (Leipzig), Vol. 208, No. 5-6, 340-60 (April, 1958).

In German.

The primary photoelectric current (defined as the current after ~ 1 sec from the beginning of illumination) in organic dyes caused by light pulses is found to increase with temperature $\propto \exp(-\Delta E_H/kT)$ in the range 15° - 80° C. Increasing temperature also causes a change in the initial rate of rise of the photoelectric current, and a decrease in the dark current after prolonged illumination. Some of the dyes are investigated in the presence of O_2 (750 mm Hg), others in vacuum. For the vacuum photoconductors an attempt is made to explain the behaviour with the aid of traps whose energy levels lie ΔE_H below the conduction band. The following dyes were investigated (film thickness $\sim 10^{-4}$ cm): the triphenyl-diphenylmethane series, fluorescein, cyanine, rhodamine, oxazine, thiazine, and azo dyes.

F. Ansbacher

5724. IMPROVED METHOD OF EVALUATING DATA ON NON-STATIONARY PHOTOCONDUCTION.

See Abstr. 5294-5

5725. INFRARED PHOSPHOR-SEMICONDUCTORS.

See Abstr. 5559

5726. CONDUCTIVITY MEASUREMENTS OF AgCl CRYSTALS.

E. Jeltsch.

Z. Naturforsch., Vol. 13a, No. 10, 899-900 (Oct., 1958). In German.

Maxima in the conductivity of AgCl, irradiated with short-wave visible light or X-rays at 20° K, occur as the temperature is increased. The conductivity peaks decay on further heating, irradiation with red light, or on application of an electric field of 2-4 kV/cm.

J. Franks

5727. STEADY STIMULATION AND QUENCHING OF PHOTOCONDUCTIVITY IN CADMIUM SULFIDE BY INFRARED RADIATION.

M. Bartenbach, B. Buras, H. Rzewuski and Z. Tomczak.

Acta phys. Polon., Vol. 17, No. 6, 389-95 (1958).

The changes in the steady photocurrent produced by exciting light in CdS single crystals by simultaneous illumination with infrared radiation have been investigated. Many authors have reported quenching of photoconductivity in CdS by infrared and some stimulation phenomena of a transient character. In the present experiments steady stimulation has been observed; this occurs when the photocurrent caused by light alone is small compared with the photocurrent caused by infrared alone. For some definite ratio of the light intensity to the infrared intensity, the illumination with infrared causes no change in the photocurrent. If the ratio is bigger than that mentioned above, the well-known quenching phenomena occur. By using X-rays instead of the exciting light, similar stimulation and quenching phenomena have been observed. These results can be explained (i) using the model proposed by Rose, which involves the creation of free holes by infrared radiation, and (ii) assuming that the current caused by infrared radiation only is associated with holes.

5728. SOME FIELD DEPENDENT EFFECTS DURING PARTIAL IRRADIATION OF CdS SINGLE CRYSTALS.

W. Thielemann.

Z. Naturforsch., Vol. 12a, No. 12, 1023-4 (1957). In German.

Measurements of photocurrents flowing in an irradiated CdS crystal, part of which was covered by opaque foils, showed that above a certain applied potential, space charge limitation occurs at the cathode side of the covered region.

J. Franks

5729. REVERSIBLE VARIATIONS OF SENSITIVITY IN CERTAIN CADMIUM SULFIDE AND SELENIDE PHOTOCONDUCTORS.

R. H. Bube.

J. chem. Phys., Vol. 30, No. 1, 266-70 (Jan., 1959).

Measurements of photoconductivity in certain CdS and CdSe crystals show the existence of relatively shallow acceptor levels with ionization energy in the 0.1 to 0.3 eV range. The photo-sensitivity normally associated with holes captured by centres with an ionization energy of 1.0 eV in CdS, and 0.6 eV in CdSe, is markedly decreased at room temperature when these shallow acceptor levels effectively replace the normal deeper levels. Such a photosensitivity decrease can be caused by illumination at room temperature for a period of time, or by heating to above 100° C, but less than about 150° C, followed by cooling to room temperature. The photosensitivity at room temperature can be increased again by heating the crystals to over about 150° C, and quenching. The process is completely reversible. In CdSe there appears to be a single level with ionization energy of 0.3 eV, whereas in CdS there appears to be a distribution of levels with ionization energies varying from about 0.15 eV to the normal 1.0 eV. The presence of the shallow levels makes possible a much faster decay of photocurrent at liquid nitrogen temperature than is usually found in sensitive crystals.

5730. EMISSION AND ABSORPTION OF LONG WAVE INFRARED RADIATION OF GERMANIUM IN THE PHOTOCONDUCTING STATE.

F. R. Kessler.

Z. Naturforsch., Vol. 13a, No. 4, 295-302 (April, 1958). In German.

By means of a focussed beam from a 1 kW projection lamp, high densities of hole-electron pairs were produced in Ge in the temperature range 20 - 70° C, and the absorption spectrum in the range 3 - 15μ was measured and was due to internal valence-band transitions of free holes. The corresponding inverse processes led to the emission of infrared radiation with a peak at 10μ . The emission intensity was roughly a linear function of lattice temperature and for small charge carrier densities a linear function of density of holes. The interpretation of the results depends on the form of the absorption edge and on the equilibrium between the two kinds of holes in the valence band. Small variations in the reflectivity due to the optical injection were looked for but not observed. Details of the experimental methods are given.

C. A. Hogarth

5731. ON THE PHOTOCONDUCTION OF GERMANIUM AFTER IRRADIATION WITH FAST ELECTRONS.

F. Stöckmann, E. E. Klontz, J. MacKay, H. Y. Fan and K. Lark-Horovitz.

Z. Phys., Vol. 153, No. 3, 331-7 (1958). In German.

After electron bombardment (4.5 MeV at 90° K) a large number

of specimens is found to show photoconduction response for radiation of up to 6μ . The spectral response and change during irradiation with electrons provide information on the defects produced. Warming to room temperature causes irreversible changes in the spectral response at longer wavelengths.

G.F.J.Garlick

537.312.5

5730. INVESTIGATION OF LEAD SULPHIDE LAYERS BY THE ELECTRIC FIELD PULSE METHOD. H.Rzewuski. Acta phys. Polon., Vol. 16, No. 4, 237-56 (1957).

A number of microcrystal layers of evaporated PbS in vacuum envelopes were investigated. The method of investigation developed by Rzewuski and Sosnowski (Abstr. 8752/1955) is discussed extensively. On the basis of this method, the following were determined: (a) the type of layer investigated; (b) the type of barrier layer; (c) the concentration and mobility of the majority carriers; (d) the minimum density of the surface states; (e) the relaxation time of the barrier; (f) the kinetic changes of the barrier-layer conductivity are discussed. The accuracy of the pulse method, as well as the possibilities of its application, is discussed.

537.312.5

5731. THE PHOTOVOLTAIC EFFECT IN STRIATED ZnS SINGLE CRYSTALS. W.J.Merz.

Helv. phys. Acta, Vol. 31, No. 6, 625-35 (1958).

The effect was studied as a function of wavelength, light intensity and temperature. Voltages of a few hundred volts can be observed if bandgap light is used and if the voltage is measured perpendicular to the striations, that is parallel to the hexagonal [0001] and the cubic [111] axes. These ZnS crystals show a very intimate intergrowth of a cubic and a hexagonal modification, which can be seen in the form of striations. It is proposed that at each transition from cubic to hexagonal symmetry, or vice versa, a barrier is formed at which the electron-hole pairs, which are created by the light, are separated and give rise to a photovoltage. Since this voltage cannot be larger than bandgap, it is assumed that the high values can occur only when all the many barriers show the same asymmetry so that the small voltages add up to a sizeable net voltage. A possible mechanism for this is shown in terms of the structure of the cubic and hexagonal ZnS. From this asymmetry of the barrier, follows also the polarity of the measured voltage. The part of the crystal which grows last (i.e. point of needle) is always the negative electrode at 3130 Å. The photovoltage increases first linearly and then logarithmically with light intensity and finally reaches saturation. The voltage increases with decreasing temperature and reaches saturation at a temperature which depends on light intensity. These results can be explained with the proposed model. From the measured curves of photovoltage v. light intensity and temperature the following parameter can be calculated. N, the number of barriers in the needles is about 2000/cm and ΔE , the barrier height is about 0.15 eV.

537.312.5

5732. ANOMALOUS PHOTOVOLTAIC EFFECT IN ZnS SINGLE CRYSTALS. A.Lempicki.

Phys. Rev., Vol. 113, No. 5, 1204-9 (March 1, 1959).

Larger-than-band gap photovoltages were observed in both cubic and hexagonal crystals of ZnS with stacking faults. Under monochromatic excitation the photovoltage measured parallel to the c axis shows two sign reversals at about 3300 and 3500 Å and peaks at approximately 3250 and 3400 Å. The position of the 3400 Å peak shifts by about 70 Å depending on the crystal structure. In the direction perpendicular to the c-axis, the photovoltage does not change sign and remains smaller than the band gap. Hexagonal crystals free of stacking faults do not show anomalous photovoltages. Heat treatment causes appearance of both. A pyroelectric polarization is found to be correlated with the sign of photovoltage.

537.312.62 : 536.21

5733. THEORY OF THE THERMAL CONDUCTIVITY OF SUPERCONDUCTORS. J.Bardeen, G.Rickayzen and L.Tewordt. Phys. Rev., Vol. 113, No. 4, 982-94 (Feb. 15, 1959).

A theory of the thermal conductivity of superconductors is presented, based on the theory of superconductivity due to Bardeen, Cooper, and Schrieffer. The excited states of the system are treated as quasi-particles, allowing a Boltzmann equation to be set up. The electronic contribution to the thermal conductivity when the dominant scatterers are impurities was calculated exactly. The result is very close to that of the Heisenberg-Koppe theory which is in fair agreement with experiment. The variational principle of Wilson has been used to find the electronic conductivity when the dominant scatterers

are lattice waves. It is concluded that the theory fails to predict the sharp drop in the ratio κ_{es}/κ_{en} as the temperature is lowered below T_c , a feature which is characteristic of the experimental results. The effect of the electrons on the lattice conductivity has also been calculated. The theoretical values may be too large.

537.312.62

5734. POTENTIAL FLUCTUATIONS IN THE TRANSITION REGION TO SUPERCONDUCTIVITY. H.Meissner. Phys. Rev., Vol. 113, No. 5, 1183-6 (March 1, 1959).

Gorter recently proposed a dynamical model to describe the state of a current-carrying wire, in the transition region to superconductivity. This model predicts in the transition region to superconductivity an alternating component of the potential difference across a wire carrying a strong direct current. The magnitude of this fluctuation should be of the order of a few per cent of the average potential. Using a shielded transformer in the liquid helium and a battery-operated preamplifier, detection of this alternating component was attempted. The noise output was somewhat larger when the sample was in the intermediate state than when it was in the superconducting state. However, instead of being a few per cent of the average potential (as in the Gorter model), this additional alternating potential was only about one hundredth of one per cent. It may be due partially to a slightly drifting bath temperature, since vibrations made it necessary to switch the pump off about 10 sec before the readings were taken.

537.312.62

5735. PENETRATION DEPTH IN IMPURE SUPERCONDUCTORS. P.B.Miller.

Phys. Rev., Vol. 113, No. 5, 1209-12 (March 1, 1959).

The equation giving the current density as a functional of the vector potential for an impurity superconductor derived by Mattis and Bardeen (Abstr. 1482/1959) is used to compute the temperature dependence of the penetration depth of impure superconductors. Results of calculations for different values of the ratio of the coherence distance to the mean free path and also for different values of the ratio of the coherence distance to the London penetration depth are given. The results are applied to tin as an example, and appreciable deviations from the $[1 - (T/T_c)^4]^{-1/2}$ temperature dependence of the penetration depth are found for all values of the mean free path.

537.312.62

5736. COLLECTIVE EXCITATIONS AND THE MEISSNER EFFECT. G.Rickayzen.

Phys. Rev. Letters, Vol. 2, No. 3, 90-1 (Feb. 1, 1959).

The Meissner effect is calculated using the B.C.S. theory, as generalized by Anderson to include collective excitations. The results are the same as those of the original B.C.S. theory, except for a small correction term, but are now gauge-invariant.

R.G.Chambers

537.312.62

5737. MEASUREMENT OF THE TEMPERATURE VARIATION OF THE ENERGY GAP IN SUPERCONDUCTING ALUMINUM.

M.A.Biondi and M.P.Garfunkel.

Phys. Rev. Letters, Vol. 2, No. 4, 143-5 (Feb. 15, 1959).

Previous microwave measurements (Abstr. 193/1958) have been extended down to $T = 0.38^\circ\text{K}$ and $\lambda = 3.1 \text{ mm}$, using a He^3 cryostat. By plotting isotherms of surface resistance against photon energy, the energy gap $\Delta E(T)$ is inferred directly. The temperature-variation is found to agree well in form with the B.C.S. theory, but $\Delta E(0) = 3.25 \text{ kT}_c$ instead of the theoretical 3.52 kT_c .

R.G.Chambers

537.312.62

5738. A UNIQUENESS THEOREM OF THE SUPERCONDUCTIVE STATE. M.Marziani.

R.C. Accad. Naz. Lincei, Vol. 25, No. 3-4, 184-8 (Sept.-Oct., 1958). In Italian.

Generalization of the theorem by F.London (Superfluids, Volume I, New York: John Wiley, 1950, p. 73-8), according to which fields and currents in a multiply connected superconductor are uniquely determined if the tangential components of the magnetic field on a closed surface surrounding the superconductor and the generalized fluxes (fluxoids) through the holes are given. It is shown that if the tangential components of the magnetic fields are given at any time $t \geq 0$, the knowledge of the initial fluxoids and of the initial value of the electric fields and their first derivative with respect to time uniquely determines the fields and currents at any instant $t \geq 0$.

H.London

537.312.62

5739. **MAGNETIC FLUX INCREASE AND RESISTANCE OF CIRCULAR INDIUM RODS AT THE SUPERCONDUCTING TRANSITION.** Y. Shibuya.
Sci. Rep. Res. Insts Tohoku Univ. A, Vol. 10, No. 5, 325-42 (Oct., 1958).

In parallel with the measurement of the magnetic flux, plotted as a function of the current at constant temperature and external magnetic field, the resistance of the same specimen was measured. The results are in good accordance with an expression derived in a modified form from the theory proposed by Meissner. The results on the paramagnetic effect obtained in the present investigation are not in a complete agreement with Meissner's theory. A possible explanation for this discrepancy is given.

537.312.62

5740. **MAGNETIC FLUX INCREASE IN NON-CIRCULAR TIN RODS AT THE SUPERCONDUCTING TRANSITION.** Y. Shibuya.
Sci. Rep. Res. Insts Tohoku Univ. A, Vol. 10, No. 5, 343-55 (Oct., 1958).

Previous studies on indium (see preceding abstract) were extended to tin, and the effect of specimen cross-section on the paramagnetic effect was investigated

537.312.62 : 538.24

MAGNETIZATION CURVES OF SUPERCONDUCTIVE TIN ALLOYS. See Abstr. 4792

537.312.62 : 536.631

SPECIFIC HEAT OF GALLIUM AND ZINC IN THE SUPERCONDUCTING STATES. See Abstr. 5634

537.312.8

5741. **GALVANOMAGNETIC EFFECTS IN THE QUANTUM LIMIT.** P.N. Argyres.

J. Phys. Chem. Solids, Vol. 8, 124-30 (Jan., 1959).

Rochester Semiconductors Conference Paper (Abstr. 4569/1959). In magnetic fields so large that all conduction electrons are in the lowest oscillator state, the time between collisions is a strong function of the magnetic field and the scattering mechanism. The galvanomagnetic effects, through their magnetic field dependences in this region provide, therefore, a sensitive tool for the study of the various scattering mechanisms. It can be established that scattering by phonons, or randomly distributed ionized impurities, can be described in the quantum limit by a relaxation time, for both longitudinal and transverse effects. The Hall coefficient and the transverse and longitudinal resistivities are calculated and compared for the two scattering mechanisms.

537.312.8

5742. **EXPERIMENTAL INVESTIGATION OF THE MAGNETO-RESISTANCE EFFECT IN CORBINO DISCS OF COPPER AND GOLD AT LOW TEMPERATURES.** G. Lautz and E. Tittes.

Z. Naturforsch., Vol. 13a, No. 10, 866-74 (Oct., 1958). In German.

The magnetoresistance effect in discs of copper and gold was measured at temperatures between 10° and 78° K. It is shown that, when the effect of the Hall field is eliminated, the magnetoresistance effect in copper and gold contains a term proportional to the square of the field. Under these circumstances metals of odd valency behave similarly to those of even valency and tend to become insulators as the magnetic field is increased. A comparison of the results with theory enables a value for the Hall constant to be determined which is in good agreement with the value determined in the usual way.

A.E. De Barr

537.312.8 : 538.2

5743. **GALVANOMAGNETIC PROPERTIES OF MANGANESE FERRITE.** K.P. Belov and E.V. Talalaeva.

Zh. eksper. teor. Fiz., Vol. 33, No. 6(12), 1517-19 (1957).

In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 6(33), No. 6, 1171-3 (June, 1958).

The longitudinal magnetoresistance $\Delta R/R$ was measured from room temperature to 350° C in fields of up to 2000 Oe. $\Delta R/R$ is negative at room temperature and falls rapidly as the temperature increases until just before the Curie point, when there is a sharp maximum. The behaviour near the Curie point is essentially similar to that of ferromagnetic metals and alloys, but in weak fields at temperatures between 240° and 260° C $\Delta R/R$ is small and positive.

C. Hilsum

5744. **ON THE FIELD DEPENDENCE OF THE HALL COEFFICIENT IN P-TYPE GERMANIUM.**

V.M. Tuchkevich and Yu.V. Shmartsev.

Zh. tekh. Fiz., Vol. 28, No. 12, 2707-10 (1958). In Russian.

It is postulated that the dependence of the Hall coefficient R on the strength of the magnetic field may be associated with the variation of the concentrations of the heavy and light holes in p-type Ge, with the concentration of the heavy holes p_H decreasing and the concentration of the light holes p_L increasing in such a manner that $p_H + p_L = \text{const}$. Based on this hypothesis, an expression for R is derived, and it is shown that the relationship $R(\Delta E)$ — determined from this expression for $\mu_L^0/\mu_H^0 = 8$ or 10 (where μ_L^0 and μ_H^0 are the mobilities of the light and heavy holes, resp.) — is in qualitative agreement with the experiment.

M.H. Sloboda

537.32 : 541.13

5745. **THE GALVANIC THERMOCELL; THE [ELECTRICAL] THERMAL ELEMENT.** E. Lange.

Z. phys. Chem. (Leipzig), Vol. 209, No. 3-4, 162-78 (Aug., 1958).

In German.

An extension of the theoretical treatment of isothermal electrochemical multiphase systems is made to non-isothermal systems and, in particular, the galvanic thermocell, the simple special case of bimetallic thermojunctions, and the non-isothermal galvanic cell are discussed.

W. Good

537.323

5746. **THERMOELECTRIC POWER OF AgBr CONTAINING CdBr.** R.W. Christy, E. Fukushima and H.T. Li.

J. chem. Phys., Vol. 30, No. 1, 136-8 (Jan., 1959).

The thermoelectric power of AgBr was measured as a function of temperature between 100 and 400° C. Measurements were made on pure material, and also on material doped with CdBr₂ in concentrations between 0.01 and 1.0 mole %. The results are compared with the theory of Howard and Lidiard. Satisfactory agreement is obtained if it is assumed that the heats of transport are temperature dependent. The values required for the sum of the heats of transport of the interstitial silver ions and vacancies are -0.57 eV at 175° and -0.69 eV at 250° C.

537.323

5747. **THERMAL E.M.F. CLOSE TO THE FUSION POINT.** M.S. Ablova and A.R. Regel.

Zh. tekh. Fiz., Vol. 27, No. 9, 2170-2 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 9, 2012-13 (Sept., 1957).

Careful measurements of the thermoelectric power of germanium were made up to about 850° - 900° C and the results extrapolated up to the melting-point. Values of order -5 to -100 μ V/deg C were obtained and seemed to indicate that the actual value was determined by the degree of constraint in the specimen which was still marked, even at high temperatures. The more compressed the sample, the lower was the thermoelectric power. The results are consistent with the well-known increase in acceptors in Ge brought about by plastic deformation.

C.A. Hogarth

537.323

5748. **A STUDY OF THE THERMOELECTRIC PROPERTIES OF LEAD TELLURIDE.**

E.Z. Gershtein, T.S. Stavitskaya and L.S. Stil'bans.

Zh. tekh. Fiz., Vol. 27, No. 11, 2472-83 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 11, 2302-13 (Nov., 1957).

A study is made of the effects of degeneracy, and of the mechanism of scattering of the carriers, on the kinetic coefficients (the thermoelectric e.m.f. and the mobility of the electrons). The effects are distinguished from each other by the introduction of compensated impurities. A study of the temperature dependences in degenerate and non-degenerate specimens makes it possible, in particular, to find out the dependence of the mean free path of the electrons on the temperature and the energy. An attempt is also made to determine the correlation between the temperature dependence of the width of the forbidden zone and the mobility.

537.323 : 536.2.08

5749. **A STUDY OF THE VOLUME-GRADIENT THERMOELECTRIC FORCE AND THERMAL CONDUCTIVITY IN GERMANIUM SINGLE CRYSTALS OF KNOWN CRYSTALLOGRAPHIC ORIENTATION.** P.I. Baranskiĭ and N.S. Konoplyasova.

Zh. tekh. Fiz., Vol. 28, No. 8, 1621-30 (1958). In Russian.

The volume-gradient thermal e.m.f. is the additional component

of e.m.f. measured with a temperature gradient present due to a resistivity gradient in the specimen. The thermal e.m.f. relative to Cu of three Ge rods (~ 40 ohm cm p-type) of differing orientations were simultaneously measured; the temperature drops used were $< 2^\circ\text{C}$; average temperatures used ranged from 25° to 70°C . Differences in the results were attributed to differences in the resistivity gradients in the specimens (the resistivity gradients were not apparently deliberate and were unknown); the differences disappeared when the specimens became intrinsic (above $\sim 50^\circ\text{C}$). The observations showed that the thermal e.m.f. relative to Cu and the thermal conductivity of Ge were isotropic as expected. Data on the thermal conductivity of Ge (77° - 370°K) is also presented. K.F.Hulme

537.324

5750. THERMOCOUPLE FOR VAPOR PRESSURE MEASUREMENT IN BIOLOGICAL AND SOIL SYSTEMS AT HIGH HUMIDITY. L.A.Richards and G.Ogata. Science, Vol. 128, 1089-90 (Oct. 31, 1958).

The vapour pressure is determined from the temperature difference between the dry and wet junctions of the thermocouple in the sample chamber, the dry junction following ambient temperature and the wet junction responding to ambient vapour pressure. The experimental assembly consisting of the thermocouple (Chromel/constantan, resistance 20 ohms) with attached Ag cylinder and the brass sample chamber, is described in detail. The thermocouple was calibrated at five points, each point being the vapour pressure of KCl at known osmotic pressure in the range 5 to 65 bars. S.Weintraub

537.362 : 535.371.07

5751. INFLUENCE OF FIRING CONDITIONS, COMPOSITION, AND SCREENING MEDIA ON THE ZETA POTENTIALS OF ZnS PHOSPHORS AS RELATED TO ADHERENCE TO GLASS SURFACES. B.Levy.

J. Electrochem. Soc., Vol. 106, No. 3, 218-24 (March, 1959). Zeta potentials were determined by the streaming potential method as a function of firing conditions, flux, activator, phosphor coating, and type and concentration of screening media. The effect of these factors on adherence was determined by the jet impingement method. Positive zeta potentials were obtained in $\text{Ba}(\text{Ac})_2$ solutions and in H_2O during all stages of phosphor preparation prior to the coating operation. Either positive or negative potentials are obtained with the finished phosphor depending on the type of coating used. Firing conditions also have been found to be important in determining the sign of the zeta potential. A general trend toward enhanced wet adherence with decreasing negative zeta potential and increasing positive zeta potential has been noted. The influence of electrolyte concentration on the zeta potentials of ZnS powders was measured with solutions of the following materials: $\text{Ba}(\text{Ac})_2$, K_2SiO_3 , $\text{Ba}(\text{Ac})_2$ - K_2SiO_3 mixtures, $(\text{NH}_4)_2\text{Cr}_2\text{O}_7$, polyvinyl alcohol, and mixtures of $(\text{NH}_4)_2\text{Cr}_2\text{O}_7$ and polyvinyl alcohol.

ELECTRIC DISCHARGES

537.521 : 539.19

5752. THERMOMETRIC STUDY OF THE FROZEN PRODUCTS FROM THE NITROGEN MICROWAVE DISCHARGE. B.J.Fontana. J. appl. Phys., Vol. 29, No. 12, 1668-73 (Dec., 1958).

Thermometric observations were made of the phenomena accompanying the stabilization and the recombination of free nitrogen atoms in a solid molecular nitrogen matrix at liquid helium temperatures. Condensation from the gas phase may occur at temperatures considerably above the 4.2°K coolant temperature as the result of the normal change in heat content and the heat of atom recombination. Estimates, made from the latter effects, of the free atom concentration in the gas phase were as high as 4 atom %. Qualitative confirmation of the presence of an energetic species stabilized in the solid phase was made by detection of heat release upon warmup. From the latter effect a minimum nitrogen atom concentration in the solid of 0.03 atom % was estimated. For the conditions used the initiation of atom recombination occurs at a temperature of about 9°K . The upper limit of about 36°K for stabilization coincides with the known thermal transition in solid nitrogen. The data suggest that at least above 9°K diffusion of nitrogen atoms occurs throughout the solid matrix during deposition from the gas phase. If recombination during warmup is diffusion-controlled, unusual dependence upon temperature is indicated.

537.523

5753. ELECTRICAL BREAKDOWN BETWEEN CLOSE ELECTRODES IN AIR. L.H.Germer.

J. appl. Phys., Vol. 30, No. 1, 46-51 (Jan., 1959).

Prebreakdown electron current between electrodes closing at voltages below the minimum which can give breakdown by successive ionization of air molecules was measured by two different methods. This field emission current varies widely in successive experiments, increasing in general with decreasing voltage, with maximum values of the order of 10^{-7} amp. At the small electrode separations characteristic of breakdown at voltages below 300, it is shown that the ions necessary for breakdown come from the anode surface. The number of ions in the space at one time is so small that they cannot cooperate to enhance the gross field at the cathode, which is a conclusion having important consequences for the theory of breakdown.

537.523 : 548.51

5754. TWO ELECTRICAL PHENOMENA ON LIQUID GERMANIUM SURFACES. A.I.Bennett.

Phys. Rev., Vol. 113, No. 3, 773-4 (Feb. 1, 1959).

This paper describes some experiments in which an electric discharge, between the surface of a molten pool of germanium and a nearby solid germanium electrode, was found to repel surface scum from the vicinity of the discharge. It also reports some experiments in which it was found possible to produce crystal nucleation by the application of a relatively low electric field to the surface of a supercooled germanium melt. No explanation for either of these phenomena is proposed.

537.523

5755. MASS SPECTROMETRY IN GAS DISCHARGES.

M.Pahl and U.Weimer.

Z. Naturforsch., Vol. 13a, No. 9, 745-53 (Sept., 1958). In German.

An arrangement is described for attaching a 60° sector field mass spectrometer to a gas discharge tube to investigate the ion energies in the plasma. A retarding field method is employed. Spectrograms of neon in the presence of hydrogen are given.

A.E.I. Research Laboratory

537.523

5756. ON THE BEHAVIOUR OF BENZENE AND ITS HOMOLOGUES IN THE POSITIVE COLUMN OF A GLOW DISCHARGE. H.Kroepelin, K.Wienke and A.Wildt.

Z. Naturforsch., Vol. 12a, No. 9, 752 (1957). In German.

Emission and absorption in the u.v. range and the reaction products of the plasma were examined following the method of Schüller (Z. Phys., Vol. 41, 381, 1940). The absorption decreased whilst the total emission increased monotonously with increase in discharge current. Solid, liquid and gaseous hydrocarbon products were formed.

A.E.D.Heylen

537.523.3

5757. AN INVESTIGATION OF THE POSITIVE POINT STREAMER CORONA. I. THE TIME DISTRIBUTION OF THE STREAMERS.

N.E.Andersson.

Ark. Fys., Vol. 13, Paper 32, 399-422 (1958).

Conical points were used and streamers obtained in the self-sustaining discharge. The time distribution of the streamers was measured and it was found that after a streamer was formed, there was a dead time t_0 during which no new streamer could be formed. A number of experiments were carried out which show that the dead time is caused by negative ions formed in the preceding streamer.

537.523.3

5758. AN INVESTIGATION OF THE POSITIVE POINT STREAMER CORONA. II. THE FIELD STRENGTH NECESSARY FOR THE STREAMER PROPAGATION. N.E.Andersson.

Ark. Fys., Vol. 31, Paper 35, 441-79 (1958).

The field strength necessary for the propagation of the positive point streamers E' was studied in 11 different gas mixtures. This field strength is highly dependent on the composition of the gas. As an example: E' is lower than 3 kV/cm in $\text{N}_2 + \text{A}$ mixtures, but is about 14 kV/cm in oxygen (atmospheric pressure). The elementary processes in the discharge that can give rise to the great difference in E' are discussed and all but one must be rejected in a qualitative study. It is only the formation of negative ions that increases in the same way as E' . A quantitative study supports the hypothesis that the increase in E' is caused by the formation of negative ions in the streamer.

537.523.4 : 534.222.2

X-RAY STUDIES OF THE SHOCK WAVES FROM SPARKS IN GASES. See Abstr. 5448

537.523.5 : 537.56

5759. ELECTRON ACCELERATION AGAINST AN OPPOSING FIELD IN A VACUUM ELECTROMAGNETIC DISCHARGE. J. Slepian.

Phys. of Fluids, Vol. 1, No. 6, 547-8 (Nov.-Dec., 1958).

In an arc discharge where both electrons and positive ions contribute to the discharge current there is no space charge limitation of current to the surrounding space. Under these conditions a swarm of electrons in a discharge plasma may gain kinetic energy while going counter to the continuous field. Examples of this effect are given and the possibility of using it to separate different types of ion briefly discussed. W.G. Townsend

537.523.5 : 535.231

5760. RADIATION LOSSES FROM ARC COLUMN. H. Pelzer. Rep. Brit. Elect. Res. Assoc., Rep. G/XT164, 19 pp. (1958).

Existing theoretical work on the radiation from high current arcs is summarized, and in parts amplified. Some of the earlier results are found to be in error and are corrected. An estimate is obtained of the total energy loss due to radiation in the temperature range from $10\,000^\circ$ to $35\,000^\circ$ K. It is in fair agreement with observation, and amounts to about one quarter of the loss due to conduction discussed in an earlier report. (See Abstr. 3531/1959).

537.523.5

5761. STUDIES OF SHORT A.C. ARCS IN AIR. II. H. Nbske. Z. angew. Phys., Vol. 10, No. 8, 382-93 (Aug., 1958). In German.

A very detailed examination of discharges between "contacts", in continuation of earlier work (Abstr. 327/1959). A double beam c.r.o. and high speed cine-camera were used. Many photographs of discharges are shown. The quenching of arcs was studied and connected with afterglow duration, etc. (for Ag contacts, etc.). Aftercurrents were studied. Gap lengths were $\sim$ mm. Temporal changes in gas temperature were connected with other parameters. J.D. Craggs

537.525

5762. STABLE CONFIGURATIONS OF A CYLINDRICAL GAS DISCHARGE. E.W. Laing.

Atomic Energy Res. Establ. (Harwell) Rep. T/M 161, 10 pp (1958).

It is shown that there exist stable configurations of a cylindrical gas discharge with the following general properties. The discharge contains a central, intermediate and outer region. The axial current flows in opposite directions in the inner and intermediate regions, and the net current is zero. In these two regions the pressure increases outwards, while in the outer region no axial current flows, and the pressure falls to zero.

537.525

5763. MULTIPACTING MODES OF HIGH-FREQUENCY GASEOUS BREAKDOWN. A.J. Hatch and H.B. Williams. Phys. Rev., Vol. 112, No. 3, 681-5 (Nov. 1, 1958).

A previously developed average electron theory for the $\frac{1}{2}$ -cycle multipacting mode of low-pressure, high-frequency breakdown (secondary electron resonance) is generalized and extended to higher order modes. A semitheoretical plot of breakdown voltage V versus the product of frequency times electrode separation $f \times d$ using representative fitting parameters is given for the $\frac{1}{2}$ -through $9/2$ -cycle modes. In addition to the customary $\frac{1}{2}$ -cycle cut-off the theory predicts a modified cut-off in each of the mode transition regions. Breakdown data for internal metal electrodes at $2\,\mu$ pressure show the typical $\frac{1}{2}$ -cycle cut off at about 100 (Mc cm)/sec plus a newly observed $\frac{3}{2}$ -cycle cut-off as indicated by a dip in the breakdown curve at about 450 (Mc cm)/sec. The $\frac{3}{2}$ -cycle dip exhibits a strong dependence on electrode surface conditions. The theory is compared with multipacting breakdown data from several sources covering a wide range of conditions, including microwave breakdown at sufficiently low pressures.

537.525

5764. FORMATION OF OXIDES OF NOBLE METALS DURING CATHODE VAPORIZATION. T. Suzuki.

Z. Naturforsch., Vol. 12a, No. 6, 497-9 (1957). In German.

When subjected to cathode vaporization in air at 5 mm Hg, gold was found (by an electron-interference method) not to form oxides, whereas Ag and Pt did oxidize: Ag to Ag_2O , Pt to (probably) PtO . Ag_2O decomposed above 250°C . F. Lachman

537.525 : 539.17 : 621.387 : 621.039

DESIGN AND PERFORMANCE OF ZETA. See Abstr. 5084

537.525 : 539.17 : 658.57 : 621.039

MODIFICATION OF ZETA IN 1958. See Abstr. 5086

537.525.

5765. STARTING POTENTIAL FOR THE LOW FREQUENCY SILENT ELECTRIC DISCHARGE IN AIR. D.P. Jatar and H.D. Sharma. Res. Bull. Saugar Univ. Phys. Soc., Vol. 2, No. 1-2, 45-50 (1957).

Observations of the threshold potentials for 50 c/s discharge using plane parallel hard and soft glass electrodes, in the range of $p \times d$ from 1 to 400 (mm Hg). cm. While Paschen's law is found to obeyed, the values of the threshold potential, for a given pd , increase in the order metal, soft glass, hard glass. It is suggested that this difference may be due to a fall in potential on the glass wall depending on the resistivity of the glass.

537.525.

5766. ON THE FORMATION OF He_2^+ AND Ne_2^+ IN A STATIONARY LOW PRESSURE POSITIVE COLUMN. M. Pahl and U. Weimer. Z. Naturforsch., Vol. 13a, No. 9, 753-7 (Sept., 1958). In German.

For various discharge pressures, in the range 0.1 to 5 mm Hg, abundance ratios of He_2^+ or Ne_2^+ to, respectively, $(\text{He}^+ + \text{HeH}^+)$ and $(\text{Ne}^+ + \text{NeH}^+)$ are given. At the highest pressures these ratios are ~ 0.15 and are still increasing with increasing pressure. The processes leading to the formation of the molecular ions are discussed. J.D. Craggs

537.525.

5767. A REMARK ON I.M. CHAPNIK'S THEORY OF THE STRIATED POSITIVE COLUMN. M.V. Konyukov.

Zh. tekhn. Fiz., Vol. 27, No. 9, 2080 (1957). In Russian. English translation in: Soviet Physics—Technical Physics (New York), Vol. 2, No. 9, 1927 (Sept., 1957).

An error in the theory of striated positive columns by Chapnik (Abstr. 5901/1956) is pointed out and corrected. A.E.D. Heyles

537.525.82

5768. MASS-SPECTROMETER STUDIES ON THE FORMATION OF $(\text{HeNe})^+$ IN THE POSITIVE COLUMN. M. Pahl and U. Weimer. Z. Naturforsch., Vol. 12a, No. 11, 926-31 (1957). In German.

Describes investigations of the ions present in low pressure (0.3 to 1.8 mm Hg) glow discharges in He-Ne mixtures. The results given graphically, show that $(\text{HeNe})^+$ ions are formed, their relative concentration increasing with total gas pressure p , and having a maximum (about 5% of that of the He^+ and Ne^+ ions for $p = 1.8$ mm) for 20 to 30% Ne mixtures at any given p . The reaction $\text{He}^+ + \text{Ne} \rightarrow \text{HeNe}^+ + e$ is discussed as a possible explanation. In Ne-A mixtures NeA^+ ions were not observed. J. Dutton

537.525.82

5769. EXPERIMENTAL INVESTIGATIONS ON THE AMBIPOLAR EFFUSION FROM THE POSITIVE COLUMN. U. Weimer.

Z. Naturforsch., Vol. 13a, No. 4, 278-85 (April, 1958). In German.

Ion production out of the positive column of a low pressure gas discharge as measured by the ion effusion current from the (undisturbed) plasma is found to correspond to a few 10^{-9} amp. in a helium discharge (discharge current 1.5-8 mA) at pressure between 0.2 and 3.9 Torr. The effusion currents depend on discharge pressure and current in the theoretically expected way. The ion current from a neon discharge was analysed with a mass spectrometer. No mass separation of the isotopes Ne^{20} and Ne^{22} through the effusion orifice could be detected. W. Good

537.529

5770. TEMPERATURE DEPENDENCE OF THE BREAKDOWN TIME-LAG IN ROCKSALT. K.K. Sonchik.

Dokl. Akad. Nauk SSSR, Vol. 123, No. 1, 76-7 (1958). In Russian.

Square pulses of 30 kV (rise-time $2-3 \times 10^{-8}$ sec) were applied across the electrodes of rocksalt plates 0.2-0.25 mm thick. The breakdown time-lag, defined as the time between the moment when the voltage across a sample reached the static breakdown value and the moment when the sample broke down, was measured. This time lag was found to increase with temperature between -70°C and $+140^\circ\text{C}$, because stronger thermal vibrations of crystal ions at higher temperatures hinder development of electron avalanches. The values of the time-lag were between 10^{-7} and 10^{-8} sec, suggesting electron mechanism of breakdown. A. Tybulewicz

537.529

5771. REMARKS ON THE ARTICLE BY COOPER AND GROSSAR "TIME DELAYS IN INTERNAL ELECTRIC BREAKDOWN OF SOLID DIELECTRICS". K.K. Sonchik.

Zh. eksper. teor. Fiz., Vol. 33, No. 5 (11), 1303 (1957). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 6(33), No. 5, 1003 (May, 1958).

Criticizes the experimental method of Cooper and Grossar (Abstr. 3234/1957), and suggests that a better procedure is to apply

individual square waves of amplitude greater than the breakdown voltage to the specimen; the time lag for NaCl at 20% over-voltage was found in this way to be $4-5 \times 10^{-8}$ sec. J.Dutton

537.529 : 537.311.33

AVALANCHE BREAKDOWN IN Si P-N JUNCTIONS. EFFECTIVE IONIZATION COEFFICIENTS. See Abstr. 5714

X-RAYS

537.531 : 551.510.535 : 523.775

X-RAYS ASSOCIATED WITH CORONAL CONDENSATIONS. See Abstr. 5326

537.531

5772. WAVELENGTH INDEPENDENT MEASUREMENT OF BEAM INTENSITY [STRAHLUNGSLEISTUNG] IN THE X-RAY REGION WITH A NaI(Tl) SCINTILLATION COUNTER. S.Buhl, H.Leutz and H.Muuss.

Z. Phys., Vol. 152, No. 3, 272-80 (1958). In German.

An NaI(Tl) crystal is provided with an axial hole to improve the capture efficiency of secondary radiation originating in the crystal. By this means the fluorescent yield remains constant over the energy range 10 to 70 keV using an air ionization chamber as a standard. The combination of this crystal with a photomultiplier enables a power level of 10^{-11} watts/cm² to be registered. T.Mulvey

537.531 : 535.33.07 : 539.1.07

5773. A PRECISION CURVED CRYSTAL X-RAY AND GAMMA-RAY SPECTROMETER. O.Beckman, P.Bergvall and B.Axelsson. Ark. Fys., Vol. 14, Paper 26, 419-37 (1958).

A spectrometer of the Du Mond type for precision measurements of energies from 20 to 350 keV. The instrument utilizes a fixed source and a moving detector, the crystal being rotated and the Bragg angle measured with a precision angular scale. The advantages of this arrangement are discussed. An experimental comparison between two methods of bending the crystal lamina is made. The instrument is calibrated with the $K\alpha_1$ lines of Mo, Ag, Sb, and W. Measurements of U $K\alpha_1$ and a gamma transition in Pt^{194} (328.49 ± 0.05 keV) are reported.

537.531 : 535.33.07

5774. A PHOTON-COUNTING, GRAZING INCIDENCE SPECTROMETER FOR THE 50-1000 A RANGE.

P.Fisher, R.S.Crisp and S.E.Williams.

Optica Acta, Vol. 5, No. 1-2, 31-9 (March-June, 1958).

A vacuum spectrometer designed for investigating the soft X-ray spectra of metals is described. Gratings of one metre radius, 570 or 1150 grooves/mm are used at 85° angle of incidence. The detector is a Cu-Be photomultiplier, intensities being recorded in terms of pulse count rates on a potentiometer recorder. A method of preliminary calibration of the spectrometer, giving wavelength in terms of the position of the photomultiplier is described. Conditions for optimum resolution and definition of the spectra are discussed. Spectra of Mg, Al, Li, Be, Na, K and Cu are reproduced. Observations were made of the effect of target contamination by oxidation and deposition of carbon. Cu M spectra are compared with those published by other workers and it is concluded that no sharp edges can be observed.

537.531 : 535.33.072

5775. A TEST FOR RESOLVING POWER OF CURVED CRYSTAL SPECTROGRAPH. T.Hayasi, T.Nishimura and M.Suzuki. Sci. Rep. Tohoku Univ. First Ser., Vol. 41, No. 4, 183-7 (Jan., 1958).

A practical method is described for testing the resolving power of a curved quartz crystal X-ray spectrograph of Johann type. A tungsten wire of diameter 25 μ , placed at a point S just on the Rowland circle and perpendicular to the plane of the Rowland circle, forms an image at a point F on the Rowland circle by entering the X-ray beam from outside the circle. The spectrograph is adjusted to form the image of the tungsten wire at the central part of the $CuK\alpha_1$ line. The halfwidth $\Delta\lambda$ of the image is estimated from a microphotometric record and is found to be 1/40.6 of the interval between $CuK\alpha_1$ and $K\alpha_2$, namely $\Delta\lambda = 0.095$ XU. The $CuK\alpha_1$ line on which the image of the tungsten wire was formed, is analysed again by the fixed crystal method or by the oscillating crystal method, and it is verified that the wavelength corresponding to the position of the image of tungsten wire is really cut off. The resolving power corresponding to the half-width of the image of the

tungsten wire is calculated as $\lambda/\Delta\lambda = 1.62 \times 10^4$ for $CuK\alpha_1$. It is possible that the spectrograph has resolving power higher than the value quoted here.

537.531 : 539.1.07

RESPONSE FUNCTIONS OF TOTAL-ABSORPTION SPECTROMETERS. See Abstr. 4880

537.531

5776. MONOCHROMATIZATION OF AN X-RAY SPECTRAL LINE. H.Barth.

Z. Naturforsch., Vol. 13a, No. 8, 680-98 (Aug., 1958). In German.

Using a particularly good specimen of a quartz crystal regions are found that give a spectral breadth of 0.02 X.U. The $CuK\alpha$ line can then be monochromatized to 1/30 of its "natural" half-width. The conditions for the realization of this are discussed in detail and consideration is given to new methods opened up for the study of crystal texture. J.Thewlis

537.531 : 535.33

5777. K SERIES X-RAY WAVELENGTHS IN RARE EARTH ELEMENTS.

E.L.Chupp, J.W.M.Du Mond, F.J.Gordon, R.C.Jopson and H.Mark. Phys. Rev., Vol. 112, No. 4, 1183-6 (Nov. 15, 1958).

The K-series X-rays in ten rare earth elements were studied with a 2 m radius bent-quartz-crystal spectrograph. A 3.7 MeV proton beam was used to produce the atomic excitations. The wavelengths obtained for the $K\alpha_1$, $K\alpha_2$, $K\beta_3$, and $K\beta_1$ lines are compared with previous wavelength measurements. Two weaker transitions, $K\beta_5$ and $KO_{II}O_{III}$, were also observed and the energies are compared with energies obtained from tables of known atomic energy levels.

537.531 : 535.331

5778. $K\alpha$ LINES OF POTASSIUM IN COMPOUNDS. S.Kiyono. Sci. Rep. Tohoku Univ. First Ser., Vol. 40, No. 1, 1-10 (Aug., 1956).

X-ray $K\alpha$ emission lines of potassium contained in crystalline powders of KCl, KBr, KI, K_2CO_3 and K_2SO_4 were studied by means of a curved crystal vacuum spectrograph with a quartz crystal curved into a radius of curvature of 50 cm and an ionic X-ray tube using dry air as discharging gas. The exposure time for a spectrogram of each compound was about 40 hr. Fresh compound was charged on the anticathode after every hour of bombardment. Two new lines $K\alpha_4(1)$ and $K\alpha_4(2)$ were observed. The mean dispersion on spectrograms was about 4.2 XU/mm, which corresponds to 3.8 eV/mm. Wavelength λ of the spectral lines, wavelength differences $\Delta\lambda$ referred to $K\alpha_2$ and the corresponding values of ν/R , $\Delta\nu/R$ and ΔV are listed. $K\alpha$ group emission lines of potassium appeared to be independent of the crystal structures of emitting compounds under the conditions of the experiment.

537.531

5779. INFLUENCE OF INDIRECT EXCITATION UPON THE INTENSITY OF A FLUORESCENT X-RAY LINE IN TWO PARTICULAR CASES. E.J.Suoninen.

Ann. Acad. Sci. Fennicae A VI, No. 15, 12 pp. (1958).

Mathematical expressions are given for the effect in a homogeneous sample. In the analysis of small amounts of arsenic in lead by measurement of the intensity of the As $K\beta$ line, it is seen that the indirect excitation by Pb $L\beta$ lines contributes roughly 10% to the total intensity observed. In the analysis of cobalt in oxidized pyrite ore (cinder), it was investigated whether the copper concentration of the sample, and especially changes in it, has an appreciable effect on the intensity of the Co $K\alpha$ line due to the indirect excitation of the Co $K\alpha$ line by the Cu $K\alpha$ and Cu $K\beta$ lines. The effect was found to be negligible within the existing concentration ranges of Co and Cu.

537.531

5780. K-SERIES FLUORESCENCE YIELDS OF VANADIUM, MANGANESE, AND NEON. W.F.Frey, R.E.Johnston and J.L.Hopkins. Phys. Rev., Vol. 113, No. 4, 1057-60 (Feb 15, 1959).

K-series fluorescence yield (w_K) measurements were made for vanadium, manganese, and neon using the proportional counter method. The values obtained are the following: vanadium, 0.304 ± 0.013 ; manganese, 0.308 ± 0.015 ; and neon, 0.043 ± 0.004 . A discussion of method and errors is given and a comparison of these values with other computed and experimental values is made.

537.531 : 535.343

5781. EXTENDED FINE STRUCTURE OF K X-RAY ABSORPTION EDGES IN PERMINVAR. R.D.Burbank and R.D.Heidenreich.

Phys. Rev. Letters, Vol. 2, No. 3, 85-7 (Feb. 1, 1959).

Reports measurements of the extended fine structures for Fe,

Co, and Ni in polycrystalline Perminvar foils (30 Fe, 25 Co, 45 Ni) which were (a) vacuum-annealed; (b) further annealed in wet hydrogen. The structures for Ni in case (a) and for Fe and Co in all cases are the same as for Ni in Ni metal. For Ni in case (b) there is an additional peak at 65 eV above the absorption edge. This is attributed to "oxygen faults" which are also believed responsible for the magnetic annealing properties of Perminvar (Abstr. 5461/1957).

D.M.Edwards

537.531 : 535.345

5782. X-RAY ABSORPTION COEFFICIENTS OF THORIUM, URANIUM, AND PLUTONIUM — EXPERIMENTAL DETERMINATION AND THEORETICAL INTERPRETATION. R.B.Roof, Jr. Phys. Rev., Vol. 113, No. 3, 820-5 (Feb. 1, 1959).

The X-ray absorption coefficients of thorium, uranium, and plutonium were determined for the $K\alpha$ and $K\beta$ radiations of silver, molybdenum, copper, cobalt, iron, and chromium. Four absorption edges were found in the wavelength region covered. These were identified as the L_{I1} , L_{II1} , L_{III1} , M_{I1} , edges and a M_{I1} , M_{II1} complex for plutonium. There is considerable disagreement between the experimental coefficients and the theoretical coefficients obtained from the Internationale Tabellen. Reasons for this discrepancy are discussed briefly. A correlation is obtained between the absorption of X-ray energy and the number of electrons in the 5f shell. Through a consideration of the atomic number, a screening constant, principal quantum numbers, and the atomic energy levels for thorium, uranium, and plutonium, the X-ray absorption coefficients of these elements were calculated. Screening constants and quantum conditions in the various equations were adjusted until, on the average, the experimental and calculated values agree within 2%. An increase in the screening constant of plutonium over that for thorium and uranium is interpreted in terms of the number of electrons occurring in the 5f shell. The change in certain quantum conditions for plutonium in comparison to those for thorium and uranium is interpreted in terms of plutonium being a subtransitional point within the 5f transition series.

537.531 : 535.345

5783. X-RAY ABSORPTION COEFFICIENTS OF THE ELEMENTS WITH $Z = 1$ TO 17 FOR Mo $K\alpha$ RADIATION. R.B.Roof, Jr. Phys. Rev., Vol. 113, No. 3, 826-7 (Feb. 1, 1959).

The X-ray absorption coefficients of the elements with $Z = 1$ to 17 (excluding helium and neon) were determined for Mo $K\alpha$ radiation. The values found in the present work are in better agreement with the earlier experimental data of Allen than with the semitheoretical values given in the Internationale Tabellen.

537.531 : 535.3

5784. EFFECT OF ABSORPTION ON MEAN WAVELENGTH OF X-RAY EMISSION LINES. A.J.C.Wilson. Proc. Phys. Soc., Vol. 72, Pt 5, 924-5 (Nov., 1958).

The use of counter techniques makes it possible to determine lattice parameters to one part in 10^6 . Absorbing material between emitter and detector can lead to an apparent shift in mean wavelength. The effect is evaluated quantitatively so that an appropriate correction may be deduced.

A.E.I. Research Laboratory

537.531 : 535.345

5785. THE ABSORPTION OF SOFT X-RAYS IN THE REGION OF THE Mg K EDGE IN MAGNESIUM. E.Baurmann and K.Ulmer. Z. Naturforsch., Vol. 12a, No. 8, 670-1 (1957). In German.

Measurements between 7 and 24 Å yielded a mass absorption coefficient equal to $9.2\lambda^{2.9}$ for $\lambda < 9.5$ Å, and $0.54\lambda^{3.0}$ for $\lambda > 9.5$ Å.

A.R.Stokes

537.531 : 539.215.08

5786. PARTICLE SIZE DETERMINATION BY SMALL ANGLE X-RAY SCATTERING. Y.Siota. Sci. Rep. Tohoku Univ. First Ser., Vol. 41, No. 1, 8-14 (Sept., 1957).

The effects of sample thickness and of the form of the beam-stop on the small-angle scattering intensity were examined experimentally. By applying the slope-analysis method the particle sizes of BeO , MgO , SiO_2 , Al_2O_3 and Fe_2O_3 were measured.

537.531 : 539.18

ATOMIC SCATTERING FACTORS FOR SPHERICAL AND ASPHERICAL CHARGE DISTRIBUTIONS. See Abstr. 5100

537.531 : 539.18

ATOMIC SCATTERING FACTOR FOR IRON. See Abstr. 5101

537.531 : 535.

5787. REFLECTION AND FOCUSING OF X-RAYS BY MIRRORS.

M.Montel. Ann. Phys. (Paris), Ser. 13, Vol. 3, No. 11-12, 859-914 (Nov.-Dec., 1958). In French.

The aberrations of various mirror systems are considered in detail, for the case of X-rays reflected at grazing incidence. With two crossed spherical mirrors it is possible to eliminate astigmatism but not coma. The application of such a focusing system to X-ray diffraction work and to the construction of an X-ray microscope are considered, and the practical construction of the system is described.

A.R.Stokes

537.531 : 535.4

5788. RÖNTGEN-RAY INTERFERENCE AT ALUMINIUM EVAPORATED LAYERS. W.Hink and W.Petzold.

Z. angew. Phys., Vol. 10, No. 12, 553-62 (Dec., 1958). In German.

Calculations (using Airy summation) of the reflecting power of Al layers of various thicknesses (250, 418.9 and 1045 Å) on glass give values for the angular position x of the interference maxima and minima in agreement with those obtained from an equation proposed by Kiessig (Abstr. 136/1932). Using an experimental method based on the measurement of x (Abstr. 8805/1958), the thickness t (400 to 3000 Å) and refractive index n of such Al films was measured. The values of t so obtained were about 50 Å less than those obtained by a Tolansky multiple beam interference method. The values of n were independent of t and were between 0.5 and 1.3% above the value for bulk Al.

J.Dutton

537.531 : 535.822

5789. THE MICROFLUOROSCOPE. H.H.Pattee, Jr. Science, Vol. 128, 977-81 (Oct. 24, 1958).

An X-ray microscope for direct visual or photometric measurements in biological specimens is described.

ELECTRON EMISSION . ELECTRON BEAMS

537.533

5790. INVESTIGATION OF THE TEMPERATURE DEPENDENCE OF THE WORK FUNCTION OF SEVERAL SEMIMETALS.

G.N.Lekhtinen, M.A.Rzaev and L.S.Stil'bans.

Zh. tekhn. Fiz., Vol. 27, No. 6, 1221-8 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 6, 1114-20 (June, 1957).

The sulphides, selenides and tellurides of lead and bismuth were studied. It was found that at temperatures below 150°C and in a vacuum of 10^{-6} mm the absolute magnitudes and temperature variations of the work functions were basically determined by adsorbed gases and vapours. At temperatures above 150°C the temperature variation of the work function differed for electron and hole semiconductors, and agreed satisfactorily with the theory and with the temperature variations of the thermal e.m.f. and the electrical conductivity. The method developed also makes it possible to evaluate the width of the forbidden band in the materials investigated.

537.533

5791. THE WORK FUNCTION OF ACTIVATED ALLOYS OF CuAlMg AND CuAlBe. V.N.Lepeshinskaya and V.A.Lebedeve.

Zh. tekhn. Fiz., Vol. 27, No. 6, 1240-7 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 6, 1131-9 (June, 1957).

The variation of the work function for the alloys was investigated at various stages of their activation and a comparison was made between the resulting values of the secondary electron emission coefficient. The variations $\Delta\phi$ in the work function were measured according to the degree of activation of the alloys by a method which involved the shifting of the current-voltage characteristics; the observed parallel displacement of the curve determined the variation in the contact potential difference between the cathode and the investigated target. Tantalum was used as a standard target. A low-voltage electron gun served as a monokinetic source of electrons. The results show that for an alloy of CuAlMg a considerable decrease in the work function is observed after activation; the specimens investigated could be divided into two groups: those with a maximum variation $\Delta\phi$ of the work function which was equal to 2.2 eV, and those with a maximum work function variation of $\Delta\phi = 1.1-1.3$ eV. For the CuAlBe alloy the variation of the work function during activation was insignificant, and the absolute value of ϕ was close to the

value of ϕ for tantalum. An attempt is made to correlate the observed variations in the work function with the conditions governing the activation process of the alloys.

537.533 : 621.385.032.213.13

5792. NOISE IN OXIDE CATHODE COATINGS.
H.J.Hannam and A. van der Ziel.
J. appl. Phys., Vol. 12, No. 12, 1702-5 (Dec., 1958).

Noise measurements have been performed on oxide-coated cathodes at frequencies of 8 Mc/s and of 30 c/s. At 8 Mc/s, where thermal noise and shot noise predominate, the measurements show thermal noise at high cathode temperatures (pore conduction region) and at low cathode temperatures (grain conduction region) with a pronounced noise peak caused by shot noise in the temperature range where pore conduction switches over to grain conduction. Noise measurements at 30 c/s where flicker noise (with a $1/f$ noise spectrum) predominates, indicate that the pore noise corresponds to the flicker noise expected for a semiconductor with a voltage-independent conductivity, whereas the grain noise corresponds to the flicker noise expected for a semiconductor with voltage-dependent conductivity. The measurements also show that the pores are inherently noisier than the grains at low frequencies. The results agree with a qualitative theoretical analysis.

537.533 : 536.422 : 621.385.032.213.13

5793. EVAPORATION OF BARIUM FROM CATHODES IMPREGNATED WITH BARIUM-CALCIUM-ALUMINATE.
I.Brodie, R.O.Jenkins and W.G.Trodden.
J. Electronics and Control, Vol. 6, No. 2, 149-61 (Feb., 1959).

The evaporation of barium was observed during the life of cathodes made with various thicknesses of two types of porous tungsten. The slow decay observed in thin cathodes of very porous tungsten appears to be due mainly to the reaction producing barium being retarded by the reaction products accumulating at the interface between the tungsten and the impregnant. The more rapid decrease for thick cathodes of lower porosity is due to the escape of barium becoming the limiting factor. This results in the reaction going to completion at increasingly greater depths within the cathode during life. The transport of barium to the surface of the cathode appears to be mainly by migration along the crystal boundaries in the impregnant and reaction products.

537.533 : 536.33 : 621.385.032.213.62

THERMAL EMISSIVITY OF ALUMINIUM OXIDE AT HIGH TEMPERATURE. USE AS VALVE HEATER COATING.
See Abstr. 5619

537.533

5794. ON THE PROBLEM OF THE TRIBO-PHOTOSTIMULATION -COELECTRON EMISSION OF ALUMINIUM SURFACES.
I.Bojkó and M.Piróg.

Z.Naturforsch., Vol. 13a, No. 9, 799-800 (Sept., 1958). In German.
Grunberg and Wright (Abstr. 3305/1956) found three spectral maxima for the photostimulated electron emission from abraded aluminium surfaces, and later studies (Abstr. 6245/1957) showed that other treatments of the surface gave similar results. Other workers, however, observed only one spectral peak using poly- and mono-crystalline specimens. The above experiments were repeated with aluminium specimens steel abraded in darkness. A maximum in electron emission response was found in the 7000 Å region using high voltages between the aluminium and the adjacent grid electrode in the counter tube system and high light intensities. The results are dependent on grid mesh size and this precludes comparison with other workers' results where the size etc. is not given.

G.F.J.Garlick

537.533 : 539.1.07

5795. ON THE PROBLEM OF THE MEASUREMENT OF THERMALLY STIMULATED CO-ELECTRON EMISSION OF EXO-ELECTRONS WITH THE USE OF SPARK COUNTERS DURING LOSS OF WATER OF CRYSTALLIZATION. B.Sujak.

Z. angew Phys., Vol. 10, No. 11, 531-6 (Nov., 1958). In German.
Warming of quinine sulphate gives rise to free electrons as water of crystallization is lost and these trigger an open spark counter above the specimen. The technique used offers a new method of examining dehydration and desorption processes.

G.F.J.Garlick.

537.533

5796. INHIBITION AND STIMULATION OF THE TENDENCY TO PHOTOSTIMULATED CO-EMISSION OF EXO-ELECTRONS BY MEANS OF A HIGH-FREQUENCY DISCHARGE IN AIR.
B.Sujak and J.Mader.

Z. Naturforsch., Vol. 13a, No. 1, 55-6 (Jan., 1958). In German.
Exo-electron emission from Al, Fe and Cu surfaces was studied in an oxygen atmosphere. Illumination by an incandescent lamp caused emission from the Al specimen but not from Fe or Cu: this emission could be inhibited by a high-frequency discharge. The results suggest that the photostimulated exo-electron emission is due to the exposure of a fresh surface (or to photo-catalytic oxidation of the surface). Specimens of Fe, Cu and Al bearing a thick oxide layer showed strong emission induced by the discharge, and in this case emission could be ascribed to lattice defects in the oxide surface.

C.H.B.Mee

537.533 : 539.1.07 : 621.383.27

RESOLUTION OF PHOTO-MULTIPLIERS IN SCINTILLATION SPECTROMETERS. See Abstr. 4869

537.533

5797. TEMPERATURE DEPENDENCE OF THE SECONDARY ELECTRON EMISSION COEFFICIENT OF NaCl FILMS.
M.V.Gomoyunova.

Zh. tekh. Fiz., Vol. 28, No. 11, 2473-5 (1958). In Russian.
Dekker (Abstr. 8345/1954) suggested that slow secondary electrons, produced by fast primary electrons, may lose energy by collisions with phonons. He derived the following equation for the temperature dependence of the secondary electron emission coefficient σ

$$\sigma_{T_1}/\sigma_{T_2} = [(2n_{\nu_2} + 1)/(2n_{\nu_1} + 1)]^{1/\nu},$$

where $n_{\nu} = 1/(e h \nu / k T - 1)$ and ν is the frequency of longitudinal lattice vibrations. This equation applies at primary energies greater than $U_{\max}$, where $U_{\max}$ is the primary energy at which a maximum of σ occurs. The present author confirmed experimentally the validity of Dekker's equation for NaCl films at temperatures from -196° to $+320^{\circ}$ C.

A.Tybulewicz

537.533 : 539.1.07 : 621.383.27

5798. STATUS OF MULTIPLIER-PHOTOTUBE DEVELOPMENT FOR SCINTILLATION COUNTERS. W.Widmaier.
I.R.E. Trans Nuclear Sci., Vol. NS-5, No. 3, 114-17 (Dec., 1958).

A number of recent developments have contributed to the design of multiplier phototubes having improved time discrimination, as well as improved pulse-height resolution. In the 6810-A, a modified version of the first commercial high-gain, high-speed tube, a curved faceplate (flat on the outside) is used to reduce transit-time variations in the region between the photocathode and the first dynode. Special geometrical construction is used to minimize transit-time spread in the 7046, a five-inch tube. Curvature of the inner faceplate is also used to improve pulse-height resolution and time discrimination of developmental versions of the 6342 and the 6655. In a new developmental tube, RCA Dev. No. C-7251, cathode curvature is combined with a new electrode structure between the cathode and the multiplier structure to reduce transit-time spread to less than a few tenths of a millimicrosecond.

537.533 : 539.1.07 : 621.383.27

5799. SPECIAL PURPOSE MULTIPLIER PHOTOTUBES FOR SCINTILLATION COUNTING. F.W.Schenkel.
I.R.E. Trans Nuclear Sci., Vol. NS-5, No. 3, 117-20 (Dec., 1958).

A discussion on linear and box-type multiplier phototubes is presented. Various aspects of dynode geometry and front end design of the Du Mont linear type multiplier structure in regard to transit time and transit-time spread are discussed. Several methods of operation of the front end of a multiplier phototube are considered in order to determine the optimum conditions for collection efficiency and transit-time spread. The mechanical requirements of various linear multiplier phototube types are discussed briefly.

537.533 : 621.383.27

5800. NOISE INVESTIGATIONS AND LINEARITY TESTS WITH PHOTOMULTIPLIERS. W.Hermann.
Z. Naturforsch., Vol. 12a, No. 12, 1006-13 (1957). In German.

Tests conducted with 10 photomultipliers have shown that, at least in the tone-frequency interval and below it, their noise spectrum is "white". Other characteristics of the noise formula have

been confirmed quantitatively to a very large extent. Deviations from linearity, considerably in excess of 1%, occur even at anode currents below 10^{-6} A; they are mostly due to reversible fatigue phenomena.

F.Lachman

537.533

5801. CORRECTION TO THE PAPER ENTITLED "ON SPACE CHARGE WAVES". R.H.C.Newton.

J. Electronics and Control, Vol. 5, No. 6, 510-13 (Dec., 1958).

See Abstr. 6273 (1957). The cyclotron frequency should be replaced by the Larmor frequency when studying Brillouin flow; this predicts the angular frequency of an electron beam in a magnetic field to be half of the corresponding frequency for a plasma.

J.Hawgood

537.533

5802. PROBLEMS OF GENERATING HIGH CIRCULATING CURRENTS OF RELATIVISTIC ELECTRONS. S.H.Neddermeyer.

J. appl. Phys., Vol. 30, No. 1, 16-22 (Jan., 1959).

The basic problems can be summarized in terms of (a) the internal kinematics, including the factors tending to dissipate the system or degrade its energy; (b) the stability of the system as a whole; (c) the initial formation, which in the view adopted here, is to be done by injection in an external magnetic field, or by some repetitive cycle of injection, acceleration and storage. Item (a) involves Coulomb scattering, especially multiple, and radiation arising from motion in the total field. The losses are described in terms of equivalent injection currents necessary to maintain a fictitious system with arbitrarily prescribed characteristics. Item (b) is discussed, mainly with reference to the "kink" instability in terms of a dynamical analogue, the breakdown of which leads to a formulation of the usually accepted necessary condition for stability. A stronger condition is also suggested, which, however, is probably much more than sufficient. The experimental difficulties of item (c) are discussed in only a general way, with no definite conclusions being drawn.

537.533

5803. FIELD SUPERPOSITION FOR INCREASING THE SENSITIVITY OF THE ELECTRON-OPTICAL SHADOW METHOD. C.Schwink and H.Murrmann.

Z. angew. Phys., Vol. 10, No. 8, 376-9 (Aug., 1958). In German.

The electron optical schlieren method of Marton and Lachenbruch (Abstr. 2566/1950) can be improved in sensitivity by superimposing a suitable magnetic field in the neighbourhood of the specimen. This is investigated analytically and experimentally. A sensitivity of 2×10^{-3} Gauss-cm was obtained.

A.E.I. Research Laboratory

537.533

5804. SIMPLE DESIGN FOR A RUBBER-SHEET APPARATUS FOR DETERMINING THE TRAJECTORIES OF CHARGED PARTICLES IN THE PRESENCE OF SPACE CHARGE.

V.M.Kel'man, K.G.Utkin and L.N.Loginova.

Zh. tekhn. Fiz., Vol. 27, No. 9, 2092-6 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 9, 1938-42 (Sept., 1957).

A graphical method of plotting trajectories is used, the space charge being simulated by pressure applied to the rubber sheet from above and realized by the weight of loaded slabs appropriately distributed on the sheet. A detailed description of the apparatus is given and equipotential lines and electron trajectories, obtained for infinite plane diodes with bounded emission regions and differing emitting surface widths, are presented graphically. From the cathode current density distribution the diode plate characteristics are plotted using the $\frac{3}{2}$ law. Agreement is found with experimental results obtained for a real diode of the same emitting surface width.

I.C.Demetopoulos

537.533 : 537.531

5805. EFFECT OF VACUUM ON ELECTRON FOCUS IN X-RAY TUBE. T.Tomita.

Sci. Rep. Saitama Univ. A, Vol. 3, No. 1, 21-6 (1958).

537.533

5806. PERIODIC FOCUSING OF HIGH CURRENT ELECTRON BEAMS. Ho Kuo-chu.

Scientia Sinica, Vol. 7, No. 12, 1247-71 (Dec., 1958).

The conditions for obtaining periodic focusing of electron beams are derived without the restriction that the beam should approximate to parallel flow conditions. Flow through a series of annular disks is considered. The potential is assumed to be a saw-tooth function.

The method is applied to the case of a series of quadrupoles. Beam profiles are calculated.

A.E.I. Research Laboratory

537.533

5807. AN INVESTIGATION OF AXIALLY SYMMETRIC MAGNETIC FIELDS FOR FOCUSING A THREE-DIMENSIONAL BEAM WITH A SPIRALING CENTRAL TRAJECTORY OF SLOWLY CHANGING RADIUS. Yu.V.Vandakurov.

Zh. tekhn. Fiz., Vol. 27, No. 6, 1319-29 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 6, 1217-28 (June, 1957).

Axially symmetric magnetic fields with a median plane (with the plane of symmetry between the pole pieces) are studied, whose shape is determined by the requirement of focusing of a wide flat beam with noncircular central trajectory. It is shown that for a nearly circular central curve the field distribution can be such that the aberrations which depend on the angle of spread in the median plane will be small compared with other aberrations. In these fields it is possible to focus a beam at a large angle. With increased focusing angle the dispersion increases as its square, whereas the aberration which depends on the width of the source and the initial angle between the trajectory and the median plane, changes little. At some angles two-directional focusing occurs. Thus the fields under investigation here can be used to construct spectrometers of large resolving power and quite high luminosity.

537.533

5808. LAWS GOVERNING THE MAGNETIC FIELD OF A BETA-TRON. B.N.Rodimov.

Zh. tekhn. Fiz., Vol. 27, No. 6, 1330-6 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 6, 1229-36 (June, 1957).

An equation is derived which describes all the properties of the focusing magnetic field in a betatron. The solution of the equation is utilized in order to compute the field of a betatron with specified properties.

537.533

5809. EFFECTIVE REGION [EXISTENZBEREICHE] OF ROTATIONALLY SYMMETRIC ELECTRON LENSES. W.Tretner.

Optik, Vol. 16, No. 3, 155-84 (March, 1959). In German.

By applying the calculus of variations, it is shown how the chromatic aberration and the aperture defect of an electron-optical system are restricted by parameters of the field and of the Gaussian dioptrics.

537.533

5810. STUDY OF MOLECULAR PATTERNS IN THE FIELD EMISSION MICROSCOPE. A.J.Melmed and E.W.Müller.

J. chem. Phys., Vol. 29, No. 5, 1037-41 (Nov., 1958).

Field emission patterns of organic dye molecules such as phthalocyanine or flavanthrene show improved stability when the tip temperature was lowered. No prior contamination or buildup is necessary for the production of typical quadruplet or doublet patterns. Upon heating or ion bombardment the molecule patterns may disappear in several distinct steps of size and intensity. On the average 13 phthalocyanine or 2 flavanthrene molecules must strike the tip to produce one pattern. These observations suggest that the substances studied here evaporate and arrive at the tip as polymerized units consisting of two to six molecules. A mechanism for image formation is proposed.

537.533

5811. ENERGY SPECTRUM RESULTING FROM ELECTRON SLOWING DOWN. R.T.McGinnies.

Circ. Nat. Bur. Stand., No. 597, 16 pp. (1959).

The process of electron slowing down is described qualitatively and the resulting energy spectrum defined in terms of differential track length. A method developed by Spencer and Fano (Abstr. 5692/1954) for the calculation of the electron spectra has been applied extensively. The accumulation of secondary knock-on electrons is included in the calculations, but bremsstrahlung losses are neglected. Tabulations of differential track length are given for aluminium, copper, tin, lead, air, water, bone, muscle, and polyethylene (C_2H_4), with up to 17 source energies each. Source energies range from 10.46 MeV to 6.438 keV. A tabulation of the probability for the production of knock-on secondary electrons is also given. [These data are a digest of a much larger tabulation, which is available on loan from the National Bureau of Standards].

5812. ELASTIC SCATTERING OF SLOW ELECTRONS IN THE FIELD OF AN ATOM. F.B.Malik. 537.533.74

Z. Naturforsch., Vol. 14a, No. 2, 172-93 (Feb., 1959). In German.

Calculation of p-wave scattering in the normal hydrogen field. The present method avoids the ambiguity of Hulthén's quadratic equation and gives almost the same result. The interrelation of the present method and the methods of Hulthén and Kohn is studied and a proposal is made that one can simultaneously satisfy the conditions $L = \int \Psi (H-E) \Psi d\tau = 0$, $\partial L / \partial a = -k$, $a k = -\langle R_l | U | j_l^+ \rangle$ appearing in the three methods. The whole discussion can without difficulty be extended to the modified Coulomb potential, only the regular and singular spherical Bessel functions being substituted by the regular and singular confluent hypergeometric functions of the Coulomb type, respectively. The phase-shifts and the wave-functions calculated without exchange agree well with the numerically solved results of Chandrasekhar and Breen. The results including exchange terms agree reasonably well with the results of the numerical integration of the Hartree-Fock equation.

537.533.74 : 539.12
ELECTRON SCATTERING FROM THIN FOILS OF Ag, Al, Au, Ni, ZAPON AND NYLON. See Abstr. 4894-6

ION EMISSION . ION BEAMS

5813. THE MOTION OF CHARGED PARTICLES IN MAGNETIC FIELDS WITH ROTATIONAL SYMMETRY. R.Lüst and A.Schlüter. 537.534
Z. Naturforsch., Vol. 12a, No. 10, 841-3 (1957). In German.

Conditions are derived for a particle to remain within a finite volume. W.A.Hepner

5814. ION CURRENT STABILIZATION FOR A SURFACE IONIZATION MASS SPECTROMETER. B.R.F.Kendall. 537.534
Rev. sci. Instrum., Vol. 29, No. 10, 851-4 (Oct., 1958).

It is shown that ion current stabilization for surface ionization mass spectrometers offers many advantages over the conventional methods of regulation which effectively stabilize the sample temperature. A technique is described which allows accurate measurement of very small relative isotopic abundances. A number of problems associated with the design of circuits for emission stabilization of surface ionization sources are considered. A successful stabilizer which maintains the ion current from such a source at a constant value by variation of the source filament temperature is described and the performance when used for the control of potassium positive ion sources is discussed. The stabilizer is capable of reducing ion current drifts, such as those due to exhaustion of the sample, by a factor of 130.

5815. MASS SPECTROMETERS WITH A RESOLVING POWER OF SEVERAL THOUSAND. B.A.Mam'rin and B.N.Shustrov. 537.534
Zh. tekhn. Fiz., Vol. 27, No. 6, 1347-56 (± 957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 6, 1246-54 (June, 1957).

Discusses the use of a magnetic resonance mass spectrometer as an analytical apparatus. Methods of increasing the beam intensity of the apparatus and of eliminating the residual current (background) are described, and a general description given of the basic units of the apparatus. Parameters are given for an apparatus designed for work with light masses.

5816. ELASTIC SCATTERING OF NEGATIVE CHLORINE AND BROMINE IONS IN ARGON, NEON AND NITROGEN. O.Rosenbaum. 537.534
Z. Naturforsch., Vol. 13a, No. 10, 838-42 (Oct., 1958). In German.

The collision cross-section was measured for Cl^- in Ne, N_2 and Ar, and also for Br^- in Ar, in the energy range 1000-4000 eV. For distances of less than 10^{-8} cm the energy of repulsion amounts to a few eV. It is likely that above a kinetic energy of 1000 eV, inelastic collisions also take place. R.Schnurmann

5817. ABSORPTION AND CHARGE REVERSAL OF NEGATIVE CHLORINE AND BROMINE IONS IN GASES. O.Rosenbaum. 537.534
Z. Naturforsch., Vol. 13a, No. 10, 842-6 (Oct., 1958). In German.

The absorption intensity was found to be linearly dependent upon pressure, so that multiple collisions are unlikely to have taken place. Above 2000 eV the absorption cross-section remained

independent of energy. The cross-sections for charge reversal were generally larger for Cl^- than for Br^- ions of similar energy, whereas the ion radii are in inverse proportion. R.Schnurmann

5818. STOPPING OF LOW-ENERGY H^+ AND He^+ IONS IN PLASTICS. D.C.Lorents and E.J.Zimmerman. 537.534
Phys. Rev., Vol. 113, No. 5, 1199-203 (March 1, 1959).

The stopping cross-sections of polystyrene, polyethylene, and GR-S rubber for 40 to 340 keV H^+ and He^+ ions were measured. A nearly monoenergetic analysed beam of ions of known energy was deflected 90° in the field of a magnetic spectrometer. A thin film of the stopping material was placed in the beam path at the spectrometer entrance. The energy loss of the beam was determined by measuring the decrease in magnetic field necessary to restore the beam to the 90° deflection angle. The film thickness was obtained by weighing a known area of film. The probable errors in the measurements are 2.3-2.8% for H^+ and 3-4% for He^+ . Proton stopping cross-section measurements on gold with this equipment agree with the results obtained by Bader, Pixley, Mozer, and Whaling. Above 75 keV the He^+ cross-sections vary linearly with the ion velocity.

PARTICLE ACCELERATORS

5819. ON A 200 keV RADIOFREQUENCY DEUTERON ACCELERATOR OF THE COCKCROFT AND WALTON TYPE. 537.54
F.Demanins and G.Poiani.

Nuovo Cimento, Vol. 11, No. 4, 593-9 (Feb. 16, 1959).

A description is given of an accelerator for the production of neutrons through the d-d and d-t reactions. Its principal characteristic is that high tension is obtained by means of a radio-frequency voltage multiplying circuit.

5820. ION PHASE MEASUREMENTS ON THE BIRMINGHAM CYCLOTRON. M.Konrad. 537.54
Rev. sci. Instrum., Vol. 29, No. 10, 840-5 (Oct., 1958).

The ion phase in the internal beam of this cyclotron, at distances from the ion source from 8 mm up to 69 cm was determined by measurements of the target current waveform. The equipment consisted of a screened target and a specially built oscilloscope based on the sampling technique. The results obtained are discussed and compared with theory. Ions are grouped in phase at early stages of acceleration over approximately 20 electrical degrees, which is about 5 times larger than predicted by the uniform electric field approximation. At later stages the measured phase changes are in good agreement with Rose's equation (1938).

5821. A CASCADED SYNCHROCYCLOTRON. 537.54
A.L.Mints and M.K.Kaminskii.

Zh. tekhn. Fiz., Vol. 27, No. 6, 1337-46 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 6, 1237-45 (June, 1957).

Describes the principle governing the arrangement of a multi-electrode accelerating system for charged particles, as well as the results of an experimental verification of this system by means of a model of a two-electrode cascaded synchrocyclotron.

5822. ON THE MAGNITUDE OF THE LOSSES OF PARTICLES THROUGH SCATTERING IN THE RESIDUAL GAS IN SYNCHROTRONS. A.N.Matveev. 537.54

Zh. tekhn. Fiz., Vol. 28, No. 8, 1829-36 (1958). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 3, No. 8, 1687-93 (Aug., 1958).

An effective method for calculating the losses of particles due to scattering in the residual gas, with the damping of the betatron oscillations taken into account in the case of a rectilinear vacuum chamber, is presented in this paper. The necessity for investigating the problem in a four-dimensional phase space is emphasized. A method for evaluating the magnitude of the losses for a vacuum chamber of arbitrary shape is indicated.

537.54 : 538.244.2 : 621.384.612

5823. A NOTE ON THE CALCULATION OF THE PROFILE OF POLE PIECES OF A STRONG FOCUSING SYNCHROTRON. L.Šípek.

Czech. J. Phys., Vol. 6, No. 6, 622-4 (Dec., 1956).

Calculations show that the pole profile is hyperbolic for synchrotrons of small radius. Deviations become more important with increasing height of the useful region and due to edge corrections for stray fields. The final shaping should be performed experimentally.

J.W.Sturgess

537.54

5824. EFFECT OF QUANTUM FLUCTUATIONS IN THE ELECTRON RADIATION OF THE SYNCHROTRON OSCILLATIONS. E.M.Moroz.

Zh. eksper. teor. Fiz., Vol. 33, No. 5(11), 1309-10 (1957). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 6(33), No. 5, 1008-9 (May, 1958).

Results of Sands (Abstr. 2784/1955) modified, taking into account damping of oscillations caused by increase in electron energy. The modifying term becomes dominant at energies of several hundred MeV and tends to unity at high energies. Compensation for radiation loss is difficult in accelerators with weak focusing and high harmonic content in the r.f. supply.

J.W.Sturgess

537.54 : 621.384.612.12

5825. FOCUSING SYSTEM FOR INJECTION OF ELECTRONS IN THE NATIONAL SYNCHROTRON. U.Amaldi, Jr.

R.C. Ist. Super. Sanita, Vol. 21, Pt 10, 896-914 (1958). In Italian.

The electron optical system is described which has been designed and constructed for focusing electrons of 2 MeV injected into a synchrotron. The electron beam is accelerated by a Cockcroft-Walton set, focused by an iron-clad magnetic lens and a quadrupole lens, and issues through an electrostatic deflector. The instantaneous electron current is 200 mA in a pulse of duration 1-5 μ sec, the exit diameter of the beam being about 5 mm and its divergence 3×10^{-3} rad. Calculations were made in Gaussian approximation, ignoring edge effects. The feeds to the magnetic lenses are mounted in a new and very simple way, which allows a stabilization of better than 1% for load resistance variations of 20%.

V.E.Cosslett

537.54

5826. CAPTURE OF ELECTRONS IN BETATRONS.

V.N.Logunov and S.S.Semenov.

Zh. eksper. teor. Fiz., Vol. 33, No. 6(12), 1513-14 (1957). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 6(33), No. 6, 1168-9 (June, 1958).

In a coordinate system moving along the equilibrium orbit with the azimuthal injection velocity of the electrons, the electrons will move towards each other. Multiple scattering will occur, the electrons will acquire a Gaussian amplitude distribution and the condition for strong damping will be fulfilled for some of the injected electrons.

J.W.Sturgess

IONIZATION . PLASMA

537.56

5827. MEASUREMENT OF SOME CHARACTERISTICS OF A STRONGLY IONIZED PLASMA. G.Vincent, F.Dumez and M.Malbec.

Ann. Radioelect., Vol. 13, 326-38 (Oct., 1958). In French.

Results are given of measurements on an ionized gas (at a temperature of the order of 10^{50} K), using u.h.f. e.m. waves.

537.56 : 534.222.2

5828. STRUCTURE OF SHOCK FRONTS IN IONIZED GASES. M.Krook.

Ann. Phys. (New York), Vol. 6, No. 2, 188-207 (Feb., 1959).

A method is given for the solution of the kinetic equations for the structure of a shock wave in an ionized gas. In an approximation of order ν , the kinetic equations are replaced by a set of $(\nu - 4)$ equations for moments of the velocity distributions. The procedure is based on a representation of the distribution functions as sums of "modified Maxwell-functions".

537.56 : 621.038 : 621.317.39

5829. MICROWAVE MEASUREMENTS IN CONTROLLED FUSION RESEARCH. M.A.Heald.

I.R.E. Nat. Convention Record, Vol. 6, Pt 9, 14-18 (1958).

Useful information about the properties of high-temperature plasmas can be obtained by microwave techniques. Consideration of the frequency dependence of electrical characteristics of an ionized medium leads to the choice of a measurement frequency near the plasma frequency. Electron density and confinement time are measured in terms of the index of refraction of the plasma, often by means of a "free-space" microwave beam. Temperature is measured by means of thermal radiation from the plasma.

537.56

5830. MICROWAVE METHOD FOR MEASURING THE PROBABILITY OF ELASTIC COLLISION OF ELECTRONS IN A GAS.

J.L.Hirshfield and S.C.Brown.

J. appl. Phys., Vol. 29, No. 12, 1749-53 (Dec., 1958).

A plasma in a d.c. magnetic field has a transverse conductivity component whose reactive part depends, as to both magnitude and sign, on the strength of the magnetic field. By measuring the value of magnetic field that is necessary for bringing this reactive part to zero — and hence removing any resonant-frequency shifts of a TE_{011} mode of a cylindrical cavity containing the plasma — determination of the probability of elastic collision of electrons in helium is obtained as a check on the method. The value of $P_m = 20 \pm 1$ cm² mm Hg⁻¹ for the electrons at room temperature thus obtained agrees substantially with the value obtained by previous workers. Sources of error in the measurement are discussed.

537.56

5831. THE RUNAWAY EFFECT IN A FULLY IONIZED PLASMA. E.R.Harrison.

Phil. Mag. (Eight Ser.), Vol. 3, 1318-25 (Nov., 1958).

The conditions for producing runaway electrons in a fully ionized gas are considered, using Chandrasekhar's coefficient of dynamic friction. The runaway currents emitted continuously from linear plasmas are then estimated and are shown to be in agreement with an order of magnitude with the results from some preliminary experimental work. The rate of increase of runaway currents in closed circuits, such as toroidal plasmas, is estimated and is found to be proportional to t^2 (t =time). From some recently published results with toroidal plasmas it is shown that the runaway current, provided it is contained and is not drastically affected by the magnetic field, can rapidly become comparable in value with the conduction current. In the experimental work with linear plasmas, X-rays were observed having an energy greater than the applied potential difference to the apparatus.

537.56

5832. MICROWAVE EMISSION FROM HIGH-TEMPERATURE PLASMAS. D.B.Beard.

Phys. Rev. Letters, Vol. 2, No. 3, 81-2 (Feb. 1, 1959).

For plasma temperatures less than 100 keV cyclotron radiation is stated to be a negligible loss mechanism. A reason for the discrepancy with previous work is given. The emission of the fundamental cyclotron frequency and the first few harmonics should however be easily detectable and provide a means of measuring electron temperature.

D.Walsh

537.56

5833. FAST ION HEATING. D.Reagan.

Phys. Rev. Letters, Vol. 2, No. 3, 82-3 (Feb. 1, 1959).

Transverse magnetic compression waves are invoked to account for part of the ion heating which occurs in "Zeta" and "Sceptre". An estimate is quoted of the magnitude of the energy available due to modes excited by the initial collapse of the discharge. The time required to give 100 eV energy to the ion is approximately 0.1 millisecond.

D.Walsh

537.56

5834. PLASMA OSCILLATION IN DEGENERATE ELECTRON GAS. C.Horie.

Sci. Rep. Tohoku Univ. First Ser., Vol. 41, No. 4, 188-94 (Jan., 1958).

An approach to the treatment of the collective behaviour of a dense system is developed, and the conditions which the collective variables representing collective motion must satisfy are given. These variables are introduced similarly to Tomonaga's treatment, but are different from it in that they contain an unknown factor which

is determined so as to satisfy the conditions mentioned above. These conditions ensure that the separation of the part representing the collective motion from the original Hamiltonian is almost complete. Application to the system of a degenerate electron gas yields a dispersion relation for the plasma frequency which is the same as that derived by Bohm and Pines.

5835. AMBIPOLAR DIFFUSION IN A POSITIVE COLUMN. 537.56
M. Pahl.

Z. Naturforsch., Vol. 12a, No. 8, 632-42 (1957). In German.
A detailed theoretical study of ambipolar diffusion, based on the earlier work of Schottky, Spenke and others. The effects of volume recombination and wall recombination are included. The results of computations are exhibited graphically. J.D.Craggs

5836. THE PLASMA CONDENSER. W.O.Schumann. 537.56
Z. Naturforsch., Vol. 13a, No. 10, 888-95 (Oct., 1958). In German.

A theoretical analysis of the behaviour of a "plasma-filled" condenser. It is shown how the maximum electron density in the plasma, and the minimum electron density at the walls of the tube carrying the discharge through the condenser, may be determined by electrical measurements. The effect of a superimposed magnetic field, in the discharge direction, is also considered. J.D.Craggs

5837. ON THE IONIZATION STATE AND THE RADIATION FROM IMPURITY GASES IN A HYDROGEN PLASMA. G.Knorr. 537.56
Z. Naturforsch., Vol. 13a, No. 11, 941-50 (1958). In German.

An interpretation formula is derived for excitation and ionization of ions which is claimed to be valid over the whole energy range of colliding electrons. This formula is used to compute a time constant which characterizes the time scale on which the ionization equilibrium of heavier ions becomes established. Elwert's ionization formula is generalized for small values of the ratio ionization-energy/KT. Neglecting interaction between radiation and plasma, the radiation of impurities, i.e. free-free, free-bound, and excitation radiation are computed. Twenty references. C.G.Morgan

5838. ON PLASMA COMPRESSION IN A MAGNETIC QUADRUPOLE FIELD. J.Christiansen. 537.56
Z. Naturforsch., Vol. 13a, No. 11, 951-61 (Nov., 1958). In German.

The conditions in which charged particles are "compressed" along the axis of a stationary magnetic quadrupole field were studied. The ion paths were investigated, using h.f. excitation of the plasma, and approximate results obtained for the equilibrium density distribution of ions. A simple relation was found between apparent plasma column diameter, the central gas temperature and the magnetic flux density at the magnet surface. The theoretical results agree reasonably well with practice for weakly ionized gases. J.D.Craggs

5839. ON WAVE PROPAGATION IN A "PLASMA CABLE" WITH EXTERNAL MAGNETIC FIELD. G.Bittner. 537.56 : 538.566
Z. angew. Phys., Vol. 10, No. 3, 117-22 (March, 1958). In German.

An experimental study of wave propagation (attenuation etc.) for frequencies varying from 100-910 Mc/s. The effects of discharge current (low pressure Hg etc.) and external field etc. on the attenuation were studied. The discharge tubes were ~50-60 cm long and some few cm in diameter. J.D.Craggs

537.56 : 532.5 : 538.3
PLASMA CONTAINED IN A TORUS. AXIALLY SYMMETRIC SOLUTIONS OF MAGNETOHYDROSTATIC EQUATIONS. See Abstr. 4838

537.56 : 532.5 : 538.3
TORUS-LIKE PLASMA CONFIGURATIONS IN EQUILIBRIUM WITH A MAGNETIC FIELD. See Abstr. 4839

537.56 : 532.5 : 538.3
STABILITY OF A GRAVITATING PLASMA IN CROSSED MAGNETIC FIELDS. See Abstr. 4840

5840. ELECTRON MOBILITY IN PARTIALLY IONIZED ATOMIC HYDROGEN. M.S.Sodha. 537.56
Phys. Rev., Vol. 113, No. 5, 1163-4 (March 1, 1959).

Hall and drift mobilities of electrons in partially ionized atomic hydrogen were investigated, taking into account the scattering by ions, neutral atoms, and other electrons.

5841. AN INVESTIGATION OF THE ENERGY OF MULTI-CHARGED IONS PRODUCED BY THE IONIZATION OF GAS ATOMS BY POSITIVE IONS. V.V.Afrosimov and N.V.Fedorenko.

Zh. tekhn. Fiz., Vol. 27, No. 11, 2557-72 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 11, 2378-90 (Nov., 1957).

A beam of A^+ or Ne^+ ions of energy $T_0 = 75$ keV was passed through a chamber filled with argon. The kinetic energy of the secondary A^+ , A^{2+} , A^{3+} , A^{4+} , A^{5+} , A^{6+} ions, which arise as a result of ionization of the atoms in single collisions, was determined. Those secondary ions were investigated which are emitted at angles $77^\circ < \varphi < 90^\circ$ with respect to the direction of the initial ion beam. It is found that the range of kinetic energy is very large: secondary ions were observed with kinetic energies ranging between fractions of and thousands of electron volts. For angles of emission $\varphi < 85^\circ$, a clear division of the secondary ions into a soft and a hard component was observed in many cases. It is shown that the possibility for the existence of both these components follows from an analysis of the energy and momentum conservation laws. The mean kinetic energy of the secondary ions of the hard component was measured as a function of the emission angle. The mean inelastic energy loss $\bar{R}$ in the collision of an ion with an atom was calculated. It was found that $\bar{R}$ may be several times greater than the sum of the ionization potentials for all the electrons of an atom which are freed in the formation of a multi-charged secondary ion. It is therefore suggested that a large amount of the kinetic energy is transferred to electrons outside the ionic and atomic shell as a result of inelastic collision. The conclusion is reached that for a given relative velocity, $\bar{R}$ is determined by the minimum separation between the nuclei of the colliding atomic particles. To a given value of $\bar{R}$ corresponds a most probable number of electrons removed from the shells of both colliding particles.

5842. EFFECT OF UNIMOLECULAR DECAY KINETICS ON THE INTERPRETATION OF APPEARANCE POTENTIALS. W.A.Chupka. 537.56
J. chem. Phys., Vol. 30, No. 1, 191-211 (Jan., 1959).

The interpretation of appearance potential data on diatomic molecules should take account of possible effects caused by predissociation, emission of light and autoionization. In the case of complex polyatomic molecules, the kinetics of predissociation and the internal thermal energy of the molecules become especially important. The intensities of the parent, fragment, and metastable ions produced by photoionization of n-propylamine, n-propanol, and methyl ethyl ketone were studied as a function of photon energy. The excess kinetic energies of the fragment ions were found to be negligibly small. The data are interpreted in terms of Rosenstock's quasi-equilibrium theory of unimolecular decomposition and indicate that the theory is qualitatively correct for the dissociative processes investigated. However, the theory is shown to be quantitatively inadequate at least in the energy range near threshold. In this region the rate constant for dissociation varies much more rapidly with energy than the theory predicts. Some of the assumptions of the theory are examined and compared to deductions from the data. The meaning of appearance potential data is examined in the light of these results. The effects of both the kinetics of dissociation and of internal thermal energy on ionization efficiency curves are significant. Most of the metals used to determine appearance potentials tend to minimize these effects and there is probably some cancellation of errors. A new method for the determination of appearance potentials is described. Experimental methods which can yield more detailed information concerning dissociation processes of complex molecular ions are suggested.

5843. MEASUREMENT OF IONIZATION POTENTIALS BY ELECTRON IMPACT. A.J.C.Nicholson. 537.561
J. chem. Phys., Vol. 29, No. 6, 1312-18 (Dec., 1958).

Compares the different methods of extracting ionization potentials from ionization efficiency curves measured by electron impact. Conventional methods are usually accurate to ± 0.1 eV but the assumptions on which they are based are such that no further increase in accuracy can be expected. These methods sometimes give wildly inaccurate results; the main cause of this is the presence of fine structure in the ionization efficiency curve. Morrison's method of determining ionization potentials, because it detects fine structure, enables measurements accurate to ± 0.002 eV to be made. Other methods which detect fine structure are equally accurate but require more complex apparatus.

5844. APPEARANCE POTENTIAL OF BF_3^+ AND BF_2^+ FROM BF_3 BY ELECTRON COLLISION. H.Kreuzer. Z. Naturforsch., Vol. 12a, No. 6, 519 (1957). In German. Mass spectrometer studies in A-BF_3 mixtures give the ionization potential of BF_3 as 15.5 ± 0.3 eV and the appearance potential of BF_2^+ as 16.25 ± 0.2 eV. J.Dutton 537.561
5845. ELECTRON IMPACT STUDIES OF SULFUR DIOXIDE AND SULFURYL FLUORIDE. R.M.Reese, V.H.Dibeler and J.L.Franklin. J. chem. Phys., Vol. 29, No. 4, 880-3 (Oct., 1958). Mass spectra and appearance potentials were obtained for principal positive and negative ions of SO_2 and SO_2F_2 . Ionic heats of formation and probable ionization-dissociation processes are tabulated. The electron-impact data for SO_2 support the values of 3.3 eV for $\text{D}(\text{S}_2)$ and 5.15 eV for $\text{D}(\text{SO})$. The molecular ionization potential is in good agreement with recent photoionization measurements. The $\Delta H_f(\text{SO}_2\text{F}_2) = -205$ kcal/M is calculated from the appearance potential of the SO_2^+ ion. Other ionic heats of formation are based on this value. The $\Delta H_f(\text{SO}^+)$ is in good agreement for both molecules. A minimum value of 3.0 eV is calculated for the electron affinity of F_2 from the appearance potential of the F_2^- ion. 537.564
5846. DISSOCIATION AND IONIZATION OF AIR BY A SHOCK WAVE. J.Thouvenin. J. Phys. Radium, Vol. 19, No. 7, 639-48 (July, 1958). In French. The composition and internal energy of air are computed for a range of temperature from 3500 up to 11500°K and a range of density from 4 up to 12 times normal density. The increase of internal energy of air by a shock wave travelling through it is evaluated in terms of the same parameters. By adjusting both expressions of energy, a relation between the temperature T and the ratio of molecular volumes V_0/V ahead and behind the shock front is obtained. The other physical variables, pressure, front velocity, material velocity, degree of ionization, can be then computed if either of parameters T or V_0/V is known. Conversely, measurement of any one physical variable makes it possible to obtain values of all the others. Calculations show the oxygen to be completely dissociated by strong shock waves (velocities above 7000 m/sec), the nitrogen by a rate 50% higher, and the concentration of free electrons to be over 0.1%. 537.564 : 534.222.2
5847. ELECTRON IMPACT IONIZATION OF Ne, O, AND N. M.J.Seaton. Phys. Rev., Vol. 113, No. 3, 814 (Feb. 1, 1959). The Bethe approximation gives a functional relation between the cross-sections for electron impact ionization (Q) and photoionization (a). Estimates of QN and QO are obtained using experimental values for QNe and calculated values for aN, aO and aNe. 537.564
5848. IONIZATION OF ATOMIC OXYGEN ON ELECTRON IMPACT. W.L.Fite and R.T.Brackmann. Phys. Rev., Vol. 113, No. 3, 815-16 (Feb. 1, 1959). The cross-section for ionization of atomic oxygen was measured by using modulated atomic beam techniques. First the ratio of the cross-sections for production of the molecular oxygen ion and for total ion production in collisions of electrons with oxygen molecules was measured. Then the ratio of the ionization cross-section of the free oxygen atom and the cross-section for production of the molecular ion in electron-molecule collisions was determined. From the previously known total ionization cross-section of the molecule, and the measured ratios, the unknown cross-sections were determined. The experimental results are compared with the calculation of Seaton (see preceding abstract). 537.564
5849. FORMATION OF H^- IONS BY ELECTRON IMPACT ON H_2 . G.J.Schulz. Phys. Rev., Vol. 113, No. 3, 816-19 (Feb. 1, 1959). The cross-section for production of H^- ions by electron impact in hydrogen gas is studied. The cross-section exhibits a plateau around 10 eV with a value of 1.2×10^{-20} cm². A sharp peak with a cross-section of 3.5×10^{-20} cm² is observed at 14.2 ± 0.1 eV. The first plateau is associated with the reaction $\text{H}_2 + e \rightarrow \text{H}^- + \text{H}$ and the sharp peak with the production of hydrogen atoms in the first excited state, $\text{H}_2 + e \rightarrow \text{H}^* + \text{H}^-$. 537.564
5850. AN EXTENSION OF THE TOWNSEND APPROXIMATE FORMULA FOR THE IONIZATION IN A HOMOGENEOUS ELECTRIC FIELD. H.Neu. Z. Phys., Vol. 152, No. 3, 294-305 (1958). In German. An expression is obtained for the mean spatial ionization α in terms of the value of E/p (E, the field, p the gas pressure) corresponding to the minimum of the Stoletow function $\bar{S} = E/\bar{\alpha}$. This expression applies over a wider range than the well known Townsend formula for α/p . A further expression is derived for the case of high fields, when $\bar{\alpha}$ is a function of both E/p and the applied voltage. J.Dutton 537.564 : 539.12
- ENERGY LOSS PER ION PAIR FOR PROTONS IN VARIOUS GASES. See Abstr. 4908 537.568
5851. ON THE CONTINUOUS ABSORPTION COEFFICIENT OF THE NEGATIVE HYDROGEN ION. IV. S.Chandrasekhar. Astrophys. J., Vol. 128, No. 1, 114-23 (July, 1958). For Pt III, see Abstr. 1414 (1947). The photoionization cross-sections of the negative ion of hydrogen are revised by making use of Hart and Herzberg's 20-parameter wave-function for the ground state. The improvements over the earlier calculations based on Henrich's 11-parameter wave-function are not very great. 537.568
5852. ON THE CONTINUOUS ABSORPTION COEFFICIENT OF THE NEGATIVE HYDROGEN ION. V. S.Chandrasekhar and D.D.Elbort. Astrophys. J., Vol. 128, No. 3, 633-5 (Nov., 1958). The photoionization cross-sections of the negative hydrogen ion derived in Paper IV, using Hart and Herzberg's 20-parameter wave-function, are further improved by replacing the plane-wave approximation for the free electron by the Hartree approximation. 537.568
5853. PHOTODETACHMENT CROSS SECTION OF THE NEGATIVE HYDROGEN ION. S.J.Smith and D.S.Burch. Phys. Rev. Letters, Vol. 2, No. 4, 165-6 (Feb. 15, 1959). The variation of the cross-section for photodetachment of electrons from H^- by photons of energy from 1 to 3 eV was obtained by an improved crossed (H^- and photon) beam technique (see Abstr. 6254/1955); the results are discussed in relation to recent theoretical computations (two preceding abstracts). J.Dutton 537.568
5854. CHARGE-EXCHANGE CROSS SECTIONS OF ARGON IONS IN HYDROGEN MOLECULES. S.B.Karmohapatro. J. chem. Phys., Vol. 30, No. 2, 538-41 (Feb., 1959). Charge-exchange cross-sections of low-energy argon ions in hydrogen are calculated by the semi-quantum mechanical impact parameter method, improved with a better approximation of the wave-functions. Cross-section curves for the reactions in the different states are compared with the experimental curve so that the part of each of the different reactions in the experiment may be evaluated approximately. 537.572
5855. SURFACE IONIZATION OF POTASSIUM ATOMS AND KCl AND CsCl MOLECULES ON TUNGSTEN FILAMENTS IN ELECTRIC FIELDS UP TO 2 MV/cm. E.Ya.Zandberg. Zh. tekh. Fiz., Vol. 27, No. 11, 2583-94 (1957). In Russian. English translation in: Soviet Physics - Technical Physics (New York), Vol. 2, No. 11, 2399-409 (Nov., 1957). Investigated (in cylindrical capacitors) the effect of electric field intensity on the temperature threshold. When the ionization of potassium atoms on tungsten occurs under a field intensity of about 2 MV/cm the temperature threshold is lowered by ~ 170 deg C. In electric fields of different intensities, the same degree of ionization of K, KCl and CsCl in the pre-threshold region of temperatures occurs at temperatures which decrease proportionally to $\sqrt{E}$, with increasing field intensity E of the filament. Surface ionization of potassium atoms under constant electric fields in the pre-threshold region of temperature leads, during the period of establishment of the current, to a temporary dependence of the threshold temperature on the density of potassium vapour and to a considerable temperature hysteresis in the pre-threshold regions of the ionization curve. 537.572

COSMIC RAYS

5856. PROGRESS IN COSMIC RAY RESEARCH SINCE 1947. 537.591
B.Peters.
J. geophys. Res., Vol. 64, No. 2, 155-73 (Feb., 1959).
Comprehensive review. Short bibliography.

5857. POINT SOURCE OF COSMIC RAYS IN ORION. 537.591 : 523.165
Y.Sekido, S.Yoshida and Y.Kamiya.
Phys. Rev., Vol. 113, No. 4, 1108-14 (Feb. 15, 1959).
By using Geiger-Müller counter telescopes with alt-azimuth mountings, a point source of cosmic rays was found. The telescopes were kept nearly horizontal so as to observe only high-energy cosmic rays which could pass through the thick layer of the atmosphere. Upon scanning the celestial sphere, a small part of it was observed again and again during the period from April, 1954 to December, 1956, and thus the existence of a point source was established. The declination of the point source was about 0.5°N and the right ascension was about 5 hr 15 min. The average momentum of the primary particles effective for this observation would be about 280 GeV/c if they are protons. In this momentum range, the time average of the intensity was about 10% of the background cosmic-rays, while there were some periodic variations during the period of observation.

5858. PHOTOGRAPHY OF COSMIC RAYS IN A LUMINESCENT CHAMBER. 537.591 : 539.1.07
M.L.Perl and L.W.Jones.
Phys. Rev. Letters, Vol. 2, No. 3, 116-17 (Feb. 1, 1959).
Minimum-ionizing cosmic rays in a NaI(Tl) crystal were photographed by means of three image-intensifier tubes coupled optically.
E.J.Burge

5859. ON THE RATIO OF PHOTONS TO ELECTRONS IN EXTENSIVE AIR SHOWERS OF COSMIC RADIATION FOUND FROM ANALYSIS OF THE TRANSITION CURVE. 537.591.1
J.M.Massalski and A.Oleś.
Acta phys. Polon., Vol. 17, No. 6, 401-8 (1958).
An analysis is made of the transition curve for particles of extensive air showers at an altitude of 2636 m above sea level. The existing discrepancy between the experimental photon-to-electron ratio (ν/e) and theory is explained. In accordance with the predictions of the theory, a large number of photons were found with energies below the threshold energy of apparatus for recording electrons. For a threshold energy for electrons of 15 MeV, for photons of 15-30 MeV, $\nu/e = 1.0 \pm 0.1$ (only the statistical error is given) below the actual value owing to the influence of the low-energy photons on the transition curve.

5860. ANALYSIS OF THE INFLUENCE OF LOW ENERGY PENETRATING PHOTONS ON THE ABSORPTION OF EXTENSIVE AIR SHOWERS IN LEAD. 537.591.3
J.Babecki.
Acta phys. Polon., Vol. 17, No. 6, 409-15 (1958).
Experimental absorption curves were obtained from which were calculated, for various thicknesses of Pb, the mean number of penetrating photons leaving the absorber during one act of coincidence and the number of these photons per electron striking the absorber. The absorption coefficient was found for the photons under study and the value of this coefficient agrees with the theoretical value for an energy range of 1.2-7 MeV. In this manner, a full picture is obtained of the phenomenon of the prolongation of the range of electron-photon cascades by photons of energies corresponding to the minimum absorption coefficient.

5861. TRANSITION EFFECT OF STARS IN A LEAD ABSORBER. 537.591.3
T.V.Varsimashvili and N.I.Kostanashvili.
Zh. eksper. teor. Fiz., Vol. 33, No. 6(12), 1530-4 (1957).
In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 6(33), No. 6, 1183-4 (June, 1958).
Nuclear emulsions placed between successive layers of lead and exposed at 3000 m above sea level were scanned for stars by three different observers to eliminate scanning losses. The results show a transition effect to a maximum rate about 25% above the unshielded rate under 3 mm of lead, and decreasing to the unshielded value under about 1 cm.
S.J.Goldsack

5862. THE INFLUENCE OF MODULATION EFFECTS ON SOLAR FLARE RADIATION. 537.591.5 : 523.75
R.R.Brown.
J. Geomagn. Geoelect. Vol. 10, No. 1, 1-6 (1958).
The modulation of cosmic rays during the 23 February 1956 solar flare cosmic-ray outburst is estimated from the latitude variation of the cosmic-ray intensity decrease observed in the period about the flare event. The perturbing influence of these modulation effects on the rigidity spectrum of the flare radiation is calculated. The change in the slope of the rigidity spectrum is found to be small, as the modulation function does not have a strong dependence on rigidity between low and middle magnetic latitudes.

5863. GEOMAGNETIC MEASUREMENTS ON HEAVY PRIMARY COSMIC RADIATION NEAR THE EQUATOR. 537.591.5
R.E.Danielson.
Phys. Rev., Vol. 113, No. 5, 1311-22 (March 1, 1959).
The azimuthal angular distribution of primary cosmic radiation with charges $Z \geq 6$ has been measured near the geomagnetic equator (at Guam) in horizontal emulsions with known orientation relative to the earth. The observed distribution is well described by using the centred-dipole approximation to the earth's surface magnetic field (north pole at 79°N and 70°W) if the effect of the solid earth is included by assuming that the main cone is the allowed cone. This verifies the prediction that the penumbra becomes forbidden near the geomagnetic equator. The main-cone equatorial cutoffs were applied to an assumed integral energy spectrum which is inversely proportional to the α power of the total energy per nucleon. The exponent α was found to be at least 1.82 ± 0.19 .

5864. MAGNETIC AND COSMIC RAY STORMS. 537.591.5 : 550.385
B.Trumpy.
Univ. Bergen Arbok, No. 2, 29 pp. (1959).
Detailed studies on individual cosmic-ray storms in different components of the cosmic radiation were carried out for the Norwegian stations at Tromsø and Bergen and for foreign stations in Germany, Japan and Tasmania. For each component, individual cases were investigated regarding the increasing phase displacement with increasing storm time between the amplitudes of the magnetic and cosmic-ray storms. The amplitude of individual cosmic-ray storms were measured for the neutrons, the soft component, the total radiation and for different hard components. In this way, valuable information is obtained regarding the dependence of the amplitude of a cosmic-ray storm on the mean energy of the primaries which have produced the cosmic-ray component in question. The dependence of cosmic-ray storms on the geomagnetic latitude was investigated for different radiation components. The diurnal variation of cosmic-ray storms was studied in a series of cases for different components and for mesons incident from different directions. Special cases of increases of the cosmic-ray intensity and their dependence on the geomagnetic latitude were reported for a period of intense solar flare activity, 18-23 September 1957. Different possibilities for a theoretical description of the cosmic-ray storm phenomena and their connection with solar activity and magnetic storms are discussed.

MAGNETISM
MAGNETIC RESONANCES

5865. MAGNETIC FIELD EXPLORATION BY A MICRO-VIBRATION METHOD. 538.08
Y.L.Yousef and H.Mikhail.
Proc. Math. Phys. Soc. Egypt, No. 21, 127-33 (May, 1957).
A new method employing microvibration technique is described for magnetic field explorations, including field gradient measurement at various points in a magnetic field of any order of magnitude encountered in practice, field variation with position, determination of magnetic centre and region of maximum field homogeneity, location of the magnetic equatorial plane, mapping lines of force, evaluation of magnetic field, determination of magnetic moments of magnets, location of the Curie region of maximum $H_y(dH_y)/(dx)$.

5866. A FEW REMARKS ABOUT THE PROTON MAGNETOMETER. 538.08
G.Klose.
Z. angew. Phys., Vol. 10, No. 11, 495-7 (Nov., 1958). In German.
Describes the proton free precession magnetometer (Packard and Varian, Phys. Rev., Vol. 93, No. 4, 941, Feb. 15, 1954). Some measurements of the variation of the earth's total magnetic field intensity at Leipzig are given.
J.G.Powles

551

538.081 : 537.081 : 53.081

EXPLANATION OF ELECTRIC AND MAGNETIC CONSTANTS AND UNITS. See Abstr. 5341

538.1 : 621.316.73

5867. THE STABILIZATION OF MAGNETIC FIELDS USING NUCLEAR RESONANCE. S.Vrščaj.

"J. Stefan" Inst. Rep., Vol. 2, 101-5 (May, 1955). In German.

Describes a 500 kg electromagnet producing a field of 2500-5400 Oe in a 5 cm air gap of 12 cm diameter and with a homogeneity better than 0.03 Oe/cm in a 2 cm sphere. A nuclear resonance stabilizer is described that maintains the field constant to 1 part in 370 000.

A.E.De Barr

538.1 : 537.54 : 621.384.612

PROFILE OF POLE PIECES OF A STRONG FOCUSING SYNCHROTRON. See Abstr. 5823

538.2 : 621.317.4

5868. COMPLETELY NONMAGNETIC ALLOY FOR INSTRUMENTATION IN MAGNETIC FIELDS. E.W.Pugh.

Rev. sci. Instrum., Vol. 29, No. 12, 1118-19 (Dec., 1958).

A high-purity copper-nickel alloy is described which has zero magnetic moment at room temperature and less than a tenth the moment of pure copper at all temperatures down to 2°K. The alloy was used with considerable advantage in sample holders for magnetic force measurements, and other uses are anticipated. A method of preparing the alloy is discussed which requires limited metallurgical equipment.

538.2

5869. DIAMAGNETISM OF CONDUCTION ELECTRONS IN METALS. J.E.Hebborn and E.H.Sondheimer.

Phys. Rev. Letters, Vol. 2, No. 4, 150-2 (Feb. 15, 1959).

Reports a calculation, exact within one-electron theory, of the diamagnetic susceptibility χ of a crystal of arbitrary symmetry oriented arbitrarily with respect to the magnetic field. The result simplifies if the crystal has a centre of symmetry and for this case an expression for χ is quoted. It is a sum of four terms: the Landau-Peierls term, a term which reduces to the atomic diamagnetism in the case of infinite lattice constant, and two further terms

D.M.Edwards

538.2

5870. PARA- AND DIAMAGNETIC SUSCEPTIBILITIES IN NON-FLUCTUATING WEAK FIELDS. W.Schriever.

Geophysics, Vol. 23, No. 4, 712-25 (Oct., 1958).

A Coulomb torsion balance apparatus was developed with which absolute measurements of para- and diamagnetic susceptibilities could be made in non-fluctuating field strengths of the order of 1 Oe. Solid specimens of the diamagnetic elements bismuth, antimony, and cadmium, were measured in fields of 2.5, 5, and 10 Oe., and the paramagnetic powders, FeCl_3 , $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$, and $\text{Co}(\text{SO}_4)_3 \cdot 7\text{H}_2\text{O}$, in fields of 2, 3, and 5 Oe. The susceptibilities decreased with increasing field strengths. A specimen of bismuth granules had lower susceptibilities than did the solid specimen made from the same supply of granules. A semi-micro balance apparatus also was constructed for absolute measurements in fields ranging between 100 and 1000 Oe. The susceptibilities of the diamagnetic specimens and a water specimen were measured. The solid bismuth, antimony and cadmium specimens and a water specimen exhibited constant susceptibilities. The susceptibility of the bismuth-granule specimen increased regularly from -4.67 to -7.87×10^{-6} c.g.s. when the field increased from 100 to 900 Oe. The value found for water (-0.73×10^{-6}) agreed well with the International Critical Tables value (-0.72×10^{-6} c.g.s.).

538.2

5871. MAGNETIC SUSCEPTIBILITIES OF URANIUM (IV) AND PLUTONIUM (IV) IONS IN CUBIC FIELDS.

G.A.Candela, C.A.Hutchison, Jr and W.B.Lewis.

J. chem. Phys., Vol. 30, No. 1, 246-50 (Jan., 1959).

The magnetic susceptibilities of (a) $[(\text{CH}_3)_4\text{N}]_2\text{PuCl}_6$, (b) $[(\text{CH}_3)_4\text{N}]_2\text{UCl}_6$, (c) Cs_2UCl_6 , of solid solutions of (d) PuO_2 in ThO_2 , and of (e) $[(\text{CH}_3)_4\text{N}]_2\text{PuCl}_6$ in $[(\text{CH}_3)_4\text{N}]_2\text{PtCl}_6$ were measured at room temperature and at the boiling point of liquid N_2 and the boiling point of liquid He. The measurements of others on (f) solid solution of UO_2 in ThO_2 are also considered. It has been found that (a), (e), and (f) show strongly temperature-dependent susceptibilities whereas (b), (c), and (d) have susceptibilities that vary only slightly with temperature over the range investigated. The results are discussed in terms of ground state configurations f^3 and f^4 perturbed by the crystal fields.

5872. EFFECT OF CRYSTAL FIELD AND SPIN-ORBIT COUPLING ON MAGNETIC SUSCEPTIBILITY OF SYSTEMS WITH f^2 ELECTRON CONFIGURATION. C.M.Herzfeld and D.B.Levine.

J. Res. Nat. Bur. Stand., Vol. 61, No. 2, 117-21 (Aug., 1958).

The effects of a crystal field of octahedral symmetry and of spin-orbit coupling on an ion with f^2 electron configuration are considered. Only fourth-degree terms in the crystal-field potential are taken into account. The eigenvalues and eigenvectors of the resulting 33×33 secular determinant are determined numerically for eight values of D/ζ , where D is a crystal-field parameter, and ζ the spin-orbit coupling constant of the ion. Perturbations by an external magnetic field are computed using second-order perturbation theory. All eigenvalues are tabulated for $D/\zeta = -10^{-4}$, -2×10^{-4} , -5×10^{-4} , -10^{-3} , -2×10^{-3} , -5×10^{-3} , -10^{-2} , -10^{-1} . They can be adapted directly to any finite nonzero positive value of ζ and, by interpolation, for values of D/ζ not tabulated. The magnetic susceptibility of a powder is calculated and displayed as a function of temperature and D/ζ , for $\zeta = \infty$, 10^3 cm^{-1} , and $5 \times 10^3 \text{ cm}^{-1}$. The relation of the results of the calculations to measurements on compounds of U^{+4} is discussed.

538.2 : 535.218 : 535.683

5873. ON PHOTOMAGNETISM AND PHOTOTROPY. I.

G.Kortüm and G.Littmann.

Z. Naturforsch., Vol. 12a, No. 5, 395-401 (1957). In German.

Measurements with a susceptibility balance on solutions of acridine orange in glycerine show a photomagnetic effect (change of susceptibility on irradiation) and confirm predictions from optical measurements that the triplet condition is strongly occupied in acridine orange.

A.E. de Barr

538.2 : 535.218 : 535.683

ON PHOTOMAGNETISM AND PHOTOTROPY. II.

See Abstr. 5598

538.2 : 537.311.33

5874. THE MAGNETIC SUSCEPTIBILITY OF SEMICONDUCTORS.

R.Bowers.

J. Phys. Chem. Solids, Vol. 8, 206-11 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Work done during the past two years on the magnetic susceptibility of charge carriers in semiconductors is reviewed briefly. The principal topics covered are related to the author's work on n-type Ge and InSb; experiments on n-type Si are also discussed.

538.2 : 537.311.33

MAGNETIC SUSCEPTIBILITY OF FOREIGN ATOMS IN SEMICONDUCTORS — THEORETICAL CONSIDERATIONS.

See Abstr. 5688

538.2

5875. TRANSFORMATIONS OF ISING MODELS. M.E.Fisher.

Phys. Rev., Vol. 113, No. 4, 969-81 (Feb. 15, 1959).

The "star-triangle" and "decoration" transformations are generalized so as to apply to arbitrary mechanical systems coupled to the spins of a standard Ising net. This leads to exact solutions for further plane Ising nets and also for lattices in which the spins on alternate sites have a magnitude greater than $S = \frac{1}{2}$. A general class of antiferromagnetic Ising models is constructed; exact closed expressions can be derived for all the thermodynamic magnetic properties of these models in an arbitrary magnetic field. The magnetizations and susceptibilities of Ising nets in which different spins have different magnetic moments are investigated and a valuable relation between the susceptibilities of the honeycomb and triangular lattices is derived. It is shown how correlation functions involving a given spin can be expressed in terms of correlations involving the nearest-neighbour spins instead.

538.2

5876. THE DE HAAS-VAN ALPHEN EFFECT IN COPPER.

D.Shoenberg.

Nature (London), Vol. 183, 171 (Jan. 17, 1959).

The effect is observed in a whisker made by the Brenner method, with the $[111]$ axis along the magnetic field. The period is $1.7 \times 10^{-8} \text{ gauss}^{-1}$ and agrees with the value for a free electron sphere of one electron per atom. Effective mass is 1.3 m.

C.A.Hogarth

5877. DEPENDENCE OF GEOMETRIC MAGNETIC ANISOTROPY IN THIN IRON FILMS. T.G.Knorr and R.W.Hoffman. Phys. Rev., Vol. 113, No. 4, 1039-46 (Feb. 15, 1959).

Thin iron films produced by vacuum deposition are observed to display a magnetic anisotropy dependent on the geometric location of the evaporating filament. A fibre axis structure is induced during the evaporation. If the direction of incidence of the metallic flux varies from a normal to the substrate this fibre axis tilts in a similar direction. As soon as the fibre axis is no longer normal to the plane of the film, magnetic anisotropy is produced. The variation of the tilt of the fibre axis correlates with and can be shown to account for the geometric dependence of the observed anisotropy. Calculations of the magnetic anisotropy expected in a film with a fibre axis structure and an anisotropic tensile stress in the plane of the film agree with the experimental observations for those films which show only rotational switching. Anisotropies of 3×10^4 ergs/cm² were observed in iron films about 350 Å thick prepared without the use of applied magnetic fields either during deposition or during a subsequent thermal anneal.

5878. ON MAGNETIC PROPERTIES OF THE ORDERABLE Fe₃Al ALLOY. V.I.Ivanovskii. Fiz. Metallov i Metallovedenie, Vol. 4, No. 1(10), 70-5 (1957). In Russian.

Coercive force, susceptibility and magnetic losses of Fe₃Al (25 atom % Al) are reported. These properties are related to the order-disorder transition which occurs at 550°C (the transition temperature is called Kurnakov's point).

5879. MAGNETIC LOSSES AT LOW TEMPERATURES. E.H.Brown and J.R.Brennan, Jr. J. appl. Phys., Vol. 30, No. 1, 112-14 (Jan., 1959).

The total magnetic losses in a silicon steel transformer core were measured at temperatures from 20° to 273°K using a variable-frequency simple-harmonic flux wave with magnetic field intensity amplitudes B_m from 2 to 10 kG. The hysteresis, or frequency independent, part of the losses was obtained by graphical extrapolation. For all field intensities this hysteresis loss increases with decreasing temperature, but the relative increase at any temperature is independent of field intensity. At all temperatures the hysteresis loss can be represented, within the accuracy of the data, by the empirical equation of Steinmetz, $W_h = w(T)B_m^n$. In addition, the exponent n in this equation was found to be independent of temperature. A figure showing the eddy-current, or frequency dependent, part of the losses for 0.014 in. laminations is also included.

5880. MAGNETIC PROPERTIES OF SPHEROIDAL GRAPHITE CAST IRON. Y.Shirakawa and T.Miyazaki. Sci. Rep. Res. Insts Tohoku Univ. A, Vol. 10, No. 6, 399-404 (Dec., 1958).

The magnetic properties of spheroidal and flake graphite cast irons of similar composition cast in sand moulds of various diameters were measured. Under the same degree of graphitization, the maximum induction, the coercive force and the hysteresis loss of spheroidal graphite cast iron were lower than those of flake graphite cast iron, and so the maximum permeability and the residual induction were higher. With increasing degree of graphitization, the maximum permeability increased, whereas the other four quantities decreased.

5881. MAGNETIC MEASUREMENTS ON FERROMAGNETIC NICKEL AMALGAM. W.Henning. Z. Naturforsch., Vol. 13a, No. 10, 897-8 (Oct., 1958). In German.

Samples of nickel amalgam were heat-treated at 265°C for different times and then cooled in liquid air. They were found to be ferromagnetic, and their magnetization and coercive force were measured.

5882. MAGNETIC ANALYSIS WITH ELECTRON BEAMS. S.Yamaguchi. Z. angew. Phys., Vol. 10, No. 3, 138-40 (March, 1958). In German.

Magnetized ferromagnetic substances cause a deflection of the electron beam in an electron diffraction camera and hence a displacement of the diffraction pattern. By measuring this displacement the remanence and other magnetic properties of a specimen may be determined.

A.E.I. Research Laboratory

5883. THE BITTER LINE PATTERNS ON SILICON-IRON CRYSTALS WITH INTERNAL STRESSES. W.Stephán. Exper. Tech. der Phys., Vol. 4, No. 4, 153-6 (1956). In German.

Stress patterns and zigzag walls occur on the (100) faces of internally stressed silicon-iron crystals. On increasing the internal stress, the volume of unfavourably oriented prisms in the end regions was reduced causing the zigzag walls to split. The maze patterns disappeared on applying a suitable external tension, magnetic measurements indicated that internal stresses could be $> 4 \times$ this tension.

5884. ON THE STRUCTURE OF THE MAGNETICALLY ORIENTED GRANULES IN ALNICO IN THE PERMANENT MAGNET CONDITION. D.Schulze. Exper. Tech. der Phys., Vol. 4, No. 5, 193-204 (1956). In German.

An electron microscope investigation reveals that the magnetically oriented particles have dimensions approximately 360×1200 Å.

5885. MAGNETIC STRUCTURE AND VACANCY DISTRIBUTION IN γ -Fe₂O₃ BY NEUTRON DIFFRACTION. G.A.Ferguson, Jr and M.Hass. Phys. Rev., Vol. 112, No. 4, 1130-1 (Nov. 15, 1958).

The diffraction pattern indicates a cubic defect spinel structure with vacancies located at octahedral lattice sites.

5886. REVERSIBLE SUSCEPTIBILITY UNDER STRESS. J.Morkowski. Acta phys. Polon., Vol. 17, No. 6, 435-53 (1958).

Measured in polycrystalline Ni by the alternating field method, for magnetic field values up to about 68 Oe. During the measurements the specimen was subject to compression and tension, the values of which varied from about -14 to +21 kg/mm². The results obtained show that application of tension lowers the value of reversible susceptibility in weak fields and increases it at more intense fields as compared with the unstressed specimen. At small compressive stresses, down to about -3 kg/mm², the picture is the reverse; at larger values of compressive stress, however, the reversible susceptibility is smaller for all values of magnetic field intensity than in the unstressed specimen. The results obtained are interpreted theoretically on the basis of statistical considerations.

5887. PRODUCTION OF MAGNETIC TEXTURE BY MEANS OF A MAGNETIC FIELD IN THIN LAYERS OF IRON, OBTAINED BY THE ELECTROLYTIC METHOD. N.V.Kotel'nikov. Fiz. Metallov i Metallovedenie, Vol. 6, No. 2, 222-8 (1958). In Russian.

This experimental study of the texture of deposits was based on the measurement (with the anisometer of Akulov-Bryukhatov) of the anisotropy of energy in Fe films obtained from aqueous solutions of Fe salts. It was found that, in electrolytically obtained ferromagnetic deposits, internal stresses are likely to produce texture; this texture depends on the following factors: material of the support, treatment of its surface prior to deposit formation, structure and material of the deposit, and the magnetic field. The texture of deposits, produced by the magnetic field, has a maximum when the field reaches several hundred oersteds; beyond this critical value the degree of texture again decreases. The energy of film anisotropy at the critical field value amounts to 5×10^4 to 6×10^4 erg/cm². When a magnetic field is applied during electrolysis along the surface of deposition of ferromagnetic films, the quality of coating is improved and its bonding with the support becomes stronger.

5888. MAGNETIC PROPERTIES OF THIN ELECTROLYTICALLY DEPOSITED AND EVAPORATED NICKEL AND IRON FILMS. L.Reimer. Z. Naturforsch., Vol. 12a, No. 7, 550-7 (1957). In German.

Gives the results of measurements of saturation magnetization, remanence, permeability and the reversible work of magnetization. There is good agreement with theoretical predictions based on single domain structures for electrolytically deposited films and films evaporated on to a hot substrate, but there are discrepancies in the case of films evaporated on to cold substrates.

538.2 : 539.23

5889. COMPARISON OF THE MAGNETIC PROPERTIES OF ELECTROLYTICALLY DEPOSITED NICKEL FILMS FROM BALLISTIC MEASUREMENTS AND FROM THE CHANGE OF ELECTRICAL RESISTANCE IN A MAGNETIC FIELD. L.Reimer.

Z. Naturforsch., Vol. 12a, No. 7, 558-61 (1957). In German.

The coercive force and the shape of the hysteresis loop derived from measurements of the change of resistance in a magnetic field are compared with results on the same films obtained by ballistic measurements. The results are discussed in relation to the magnetization process in single domain films.

A.E.De Barr

538.2 : 539.23

5890. MAGNETIC INVESTIGATIONS ON ELECTROLYTICALLY DEPOSITED THIN COBALT FILMS. L.Reimer.

Z. Naturforsch., Vol. 12a, No. 12, 1014-15 (1957). In German.

Cobalt films, deposited electrolytically on copper, have a cubic structure. By extrapolation in accordance with an exponential law the crystal anisotropy constants of cubic cobalt at 20°C and -190°C have been found, and the measured coercive forces of thin films are in agreement with those calculated using these values. The coercive force is much less than the value calculated from the anisotropy constant of hexagonal cobalt.

A.E.De Barr

538.2

5891. THE DETERMINATION OF THE DISTRIBUTION OF THE MAGNETIZATION VECTORS IN EVAPORATED FILMS OF NICKEL AND IRON FROM THE MAGNETORESISTANCE EFFECT.

W.Hellenthal.

Z. Phys., Vol. 153, No. 3, 359-71 (1958). In German.

For films deposited at high temperatures, in thicknesses less than about 300 Å, the magnetization vectors lie approximately in the plane of the film. In nickel film deposited on to unheated substrates no such distribution was found: this can be explained in terms of stresses in the films.

A.E.De Barr

538.2 : 538.652

5892. ON THE EFFECT OF MAGNETIC FIELD COOLING ON MAGNETOSTRICTION OF 45-25 PERMINVAR AND 65 PERMALLOY. M.Sugihara.

Sci. Rep. Tohoku Univ. First Ser., Vol. 41, No. 1, 21-34 (Sept., 1957).

The magnetostriction of these alloys was measured after they had been cooled in longitudinal magnetic fields, 13.3 and 9.6 Oe, respectively, from various temperatures. When the former alloy was cooled from 475°, the obvious discontinuous change of magnetostriction was observed in the vicinity of 465 Oe. When the latter alloy was cooled from 480°, the magnetostriction curve showed several discontinuous changes taking place step by step. It is suggested that this effect intimately relates to the order-disorder transformation.

538.2 : 539.217.1

5893. DEPENDENCE OF THE MAGNETIC PROPERTIES OF SINTERED PERMANENT MAGNETS ON POROSITY. A.B.Al'tman. Fiz. Metallov i Metallovedenie, Vol. 4, No. 1 (10), 84-8 (1957). In Russian.

The effect of porosity on the magnetic properties of sintered Alni (Al-Fe-Ni), Alnico, Magnico (Al-Co-Fe-Ni) and Cunico (Cu-Ni-Co) magnets is reported.

538.2

5894. MAGNETIC MATERIALS WITH THE PERMINVAR EFFECT. III. THE DEPENDENCE BETWEEN OVER-STOICHIOMETRIC OXYGEN CONTENT AND PERMINVAR EFFECT IN FERRITES CONTAINING COBALT. A.v.Kienlin.

Z. angew. Phys., Vol. 10, No. 4, 167-9 (April, 1958). In German.

For Pt II, see Abstr. 8124 (1958). Hysteresis loop measurements on specimens of magnetite and a mixed ferrite, each containing small amounts of cobalt are reported. The contribution of metal ion vacancies to the Perminvar effect in these materials is discussed.

A.J.Manuel

538.2

5895. MAGNETIC MATERIALS WITH THE PERMINVAR EFFECT. IV. PERMINVAR EFFECT AND MAGNETIC ANNEALING EFFECT IN CONNECTION WITH AFTER-EFFECT PHENOMENA IN FERRITES CAUSED BY ELECTRON DIFFUSION. A.v.Kienlin.

Z. angew. Phys., Vol. 10, No. 12, 562-5 (Dec., 1958). In German.

Samples of Mn ferrite and of Co Mn ferrite that showed temperature and frequency dependent after-effects at room temperature were found to have Perminvar-type hysteresis loops at -180°C. This

effect is attributed to the freezing-in of the electron diffusion responsible for the after-effect. In the temperature region between -180°C and -50°C a magnetic annealing effect occurs. At -100°C the effect of the measuring field alone quickly produces markedly rectangular hysteresis loop.

A.E. De Barr

538.2

5896. SOME INVESTIGATIONS ON Li-Zn FERRITES.

Kh. S. Valeev, N.G.Drozdov and A.L.Frumkin.

Zh. tekhn. Fiz., Vol. 27, No. 11, 2517-27 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 11, 2341-50 (Nov., 1957).

A study was made of the sintering and physical properties. The sintering process was studied mainly by means of thermograms. On the basis of these, conclusions were drawn as to the formation temperature of Li ferrites and the reaction of the ferrite with the atmosphere during sintering, etc. A comparison was made between Li and Ni ferrites. As a result of studying the effect of composition and sintering temperature on the magnetic properties of Li-Zn ferrites, materials have been obtained which have small losses in the range 20-75 Mc/s. The frequency dependences of the real and imaginary parts of the magnetic permeability were determined for this range. The magnetic permeability of the ferrites was also measured in the very high-frequency region. Data were obtained on the dependence of absorption in the ferrite at a wavelength of 3.2 cm on constant magnetic fields. The thermal expansion of Li-Zn ferrite was measured over a wide temperature range. It was found that an anomaly in the temperature dependence of the coefficient of thermal expansion occurs at the Curie point.

538.2

5897. THEORY OF MAGNETOSTRICTION AND g-FACTOR IN FERRITES. N.Tsuya.

Rep. Res. Inst. Elect. Commun. Tohoku Univ. B, Vol. 8, No. 4, 161-255 (March, 1957).

The electronic structures of various ferrites are determined theoretically, using the one-ion model based on the Heitler-London approximation. Spin-orbit interactions are discussed fully by means of perturbation theory, and the g-factors calculated for the ferrites agree well with those observed in microwave resonance absorption. The perturbation terms for the various possible mechanisms for magnetostriction are obtained and the predominant mechanism in each ferrite could be determined, as the calculated magneto-mechanical coupling energies agree quite well with the experimental values.

R.C.Kell

538.2

5898. EFFECT OF NEUTRON IRRADIATION ON THE CURIE TEMPERATURE OF A VARIETY OF FERRITES.

E.I.Salkovitz, G.C.Bailey and A.I.Schindler.

J. appl. Phys., Vol. 29, No. 12, 1747-8 (Dec., 1958).

A variety of commercially available ferrites were irradiated in the Brookhaven reactor to a total integrated flux of 1.2×10^{17} nvt (fast), at a temperature of 50°C. None of the samples showed a significant change in the Curie temperature.

538.2 : 537.312.8

GALVANOMAGNETIC PROPERTIES OF MANGANESE FERRITE. See Abstr. 5743.

538.2

5899. ANTIFERROMAGNETIC PROPERTIES OF THE IRON GROUP TRIFLUORIDES.

E.O.Wollan, H.R.Child, W.C.Koehler and M.K.Wilkinson.

Phys. Rev., Vol. 112, No. 4, 1132-6 (Nov. 15, 1958).

A neutron diffraction study was made of the trifluorides of 3d transition group elements. The arrangement of the magnetic ions and the anions in these trifluorides is similar to that in the compounds LaMO_3 . No antiferromagnetic transition was observed in VF_3 . In the compounds CrF_3 , FeF_3 , and CoF_3 the magnetic ions are observed to couple antiferromagnetically via the intervening anion to each of their six nearest neighbours. This is the same structure as that found in the compounds LaCrO_3 and LaFeO_3 . In the trifluorides the distortions from cubic symmetry have made it possible to determine the orientation of the spin moments relative to the crystallographic axes and in one case (CrF_3) the antiferromagnetic domain properties were studied with magnetic fields applied to the sample. In MnF_3 an antiferromagnetic layer structure is found of the type previously observed for LaMnO_3 . The indirect magnetic coupling in these compounds is correlated with the orbitals which result from the splitting of the d-levels by the crystalline field.

5900. TEMPERATURE DEPENDENCE OF ANISOTROPY ENERGY IN ANTIFERROMAGNETS. P.Pincus. Phys. Rev., Vol. 113, No. 3, 769-70 (Feb. 1, 1959).

The Akulov-Zener classical theory of the temperature dependence of ferromagnetic anisotropy energy is extended to the antiferromagnetic case. The result, for short-range interactions only, is that

$$K_n(T)/K_n(0) = [M(T)/M(0)]^{n(n+1)/2},$$

where $K_n(T)$ is the n -th order anisotropy constant and $M(T)$ is the sublattice magnetization. Here, $K_n(0)$ and $M(0)$ refer to the corresponding quantities at absolute zero. The result is verified by a spin-wave calculation.

5901. EXCITATION OF SPIN WAVES IN AN ANTIFERROMAGNET BY A UNIFORM RF FIELD. R.Orbach and P.Pincus. Phys. Rev., Vol. 113, No. 5, 1213-15 (March 1, 1959).

It is possible to excite spin-waves in an antiferromagnet provided that spins on the surface of the specimen experience anisotropy interactions different from those acting on the spins in the interior. Modes with an odd number of half-wavelengths should be excited in a flat plate. The condition for different anisotropy interactions is worked out and proves to be a lenient condition. Experiments which would determine the exchange energy constant and the anisotropy field should be possible using sufficiently thin platelets of single crystals having parallel faces.

5902. ABSORPTION LINES IN THE ANTIFERROMAGNETIC STATES OF $MnCl_2 \cdot 4H_2O$ AND $MnBr_2 \cdot 4H_2O$. See Abstr. 4445

5903. INTERNAL FERROMAGNETIC RESONANCE IN NICKEL. J.C.Anderson and B.Donovan. Proc. Phys. Soc., Vol. 73, Pt 4, 593-9 (April, 1959).

The internal resonance, revealed by measurements of the complex permeability, was investigated in nickel over the temperature range 5°-100° C. The resonant frequency is found to be a decreasing function of temperature and, over the range studied, the variation is roughly from 450 to 300 Mc/s in the case of a polycrystalline disk, and from 270 to 40 Mc/s in the case of a colloidal suspension of nickel particles. This behaviour is consistent with the view that the resonance is due to the internal magnetic field associated with the anisotropy energy and a quantitative interpretation is attempted using the available experimental values for the anisotropy constants.

5904. THE MAGNETOSTRICTIVE DISPLACEMENT OF THE FERROMAGNETIC RESONANCE IN Ni-Fe WIRES. V.Zehler. Z. Naturforsch., Vol. 12a, No. 5, 441-3 (1957). In German.

Ferromagnetic resonance occurs in smaller magnetic fields when a tension is applied to the wire. It is shown that the displacement can be accounted for in terms of the effect of the tension on the free energy of the spins, and it is suggested that the effect forms the basis of a useful method of measuring magnetostriction.

5905. EFFECTIVE FERRIMAGNETIC RESONANCE PARAMETERS WITH GILBERT-TYPE RELAXATION TERMS. R.K.Wangness. Phys. Rev., Vol. 113, No. 3, 771-2 (Feb. 1, 1959).

Steady-state effective parameters of the susceptibility tensor were found for a two-sublattice system by using equations of motion with Gilbert-type relaxation terms. To the same order in the molecular field coefficient, these parameters differ from those previously found for Landau-Lifschitz type terms in that they have infinite discontinuities in the compensation region, there is no distinction between the effective gyromagnetic ratios characterizing the absorption and the Faraday effect, and there is no additional term appearing in the expression for the off-diagonal element.

5906. KNIGHT SHIFT IN SODIUM-AMMONIA SOLUTIONS. See Abstr. 5413

5905. A PARAMAGNETIC RESONANCE MICROWAVE SPECTROMETER FOR THE STUDY OF CHEMICAL REACTIONS. S.E.Bresler, E.M.Saminskiĭ and Ė.N.Kazbekov. Zh. tekh. Fiz., Vol. 27, No. 11, 2535-53 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 11, 2357-74 (Nov., 1957).

The limit of sensitivity is calculated for different types of microwave spectrometer designed for the investigation of free radicals in chemical reactions. It is shown that the best types are a spectrometer with high-frequency magnetic-field modulation and semiconductor diodes as emission receivers and a spectrometer with a "transmission" resonator and a bolometric energy converter at low modulation frequency. A description is given of a spectrometer of the latter type, the limit of sensitivity of which reaches 2×10^{-13} mole of diphenylpicrylhydrazyl, and is close to the computed limit of sensitivity. Ways of further increasing the sensitivity are considered.

5906. AN X-BAND SPECTROMETER FOR THE DETECTION OF PARAMAGNETIC RESONANCES. W.Stieler. Z. angew. Phys., Vol. 10, No. 2, 89-95 (Feb., 1958). In German.

A sensitive 8.2-12.4 kMc/s magic T microwave bridge spectrometer is described. A modified Pound circuit is used to compensate for dispersion. The hyperfine structure of Mn^{++} ions in aqueous solution of $MnSO_4$, absorption lines in electron bombarded NaCl, and in both heat treated and electron bombarded anthracene have been observed. No resonance was detected in X-ray irradiated NaCl or u.v. irradiated fluorescein in boric acid.

5907. ELECTRON PARAMAGNETIC RESONANCE OF MANGANESE (II) IN HEXAGONAL ZINC OXIDE AND CADMIUM SULFIDE SINGLE CRYSTALS. P.B.Dorain. Phys. Rev., Vol. 112, No. 4, 1058-60 (Nov. 15, 1958).

The values of the crystal field parameters were obtained from the spectra and the signs of the parameters were determined from the temperature dependence of the intensities of the peaks. In addition to the expected thirty resonances for Mn^{++} in CdS, superhyperfine splittings of each peak were observed, which result from an interaction of the Mn^{++} electrons with the nearest neighbour cadmium nuclei.

5908. PARAMAGNETIC RESONANCE OF Fe^{3+} IN $SrTiO_3$ SINGLE CRYSTALS. K.A.Müller. Helv. phys. Acta, Vol. 31, No. 3, 173-204 (1958). In German.

The paramagnetic resonance spectrum was investigated at 3.2 cm wavelength. The concentration of the ions was about 10^{17} cm^{-3} . The measurements were made at room temperature and at 80° K in function of the orientation of the constant magnetic field to the crystal axes. The variation of the fine structure can be explained using a spin-Hamiltonian. At room temperature, where the $SrTiO_3$ is cubic, the splitting at zero magnetic field $|3a|$ is $(5.95 \pm 0.30) \times 10^{-2} \text{ cm}^{-1}$, $D = 0$ and $g = 2.004 \pm 0.001$. It follows from the magnitude of $|3a|$ that the Fe^{3+} is situated at Ti^{4+} lattice points. The small deviation of the line positions from the theoretical values is ascribed to partial covalent bonding of the Fe with the neighbouring O atoms. At liquid nitrogen temperature, where the $SrTiO_3$ is tetragonal $|3a|$ is 1.11 times greater and $|D| = (7.7 \pm 0.3) \times 10^{-4} \text{ cm}^{-1}$. At this temperature the lines

$$\pm 5/2 \leftrightarrow \pm 3/2 \text{ and } \pm 3/2 \leftrightarrow \pm 1/2$$

split if the magnetic field is along the [100] direction and not if it is along the [111] direction. This shows, that the $SrTiO_3$ single crystal consists of tetragonal domains below the phase change which begins at 100° K. A short description of the resonance spectrometer employed is given.

5909. ELECTRON SPIN RESONANCE STUDIES OF IRRADIATED TEFLON: EFFECTS OF VARIOUS GASES. H.N.Rexroad and W.Gordy. J. chem. Phys., Vol. 30, No. 2, 399-403 (Feb., 1959).

The radical produced by X- or γ -irradiation of polyfluorethylene (Teflon) in a high vacuum was shown to have five F atoms with nuclear coupling to the electron spin, four with equivalent coupling of

33 gauss each and a fifth with coupling of 92 gauss. The radical is probably of the form $\text{XCF}_2\text{CFCF}_2\text{Y}$, where X and Y represent the continuing Teflon chains with no significant electron spin density. Molecular oxygen was found to combine with undetectable radicals or ions in the irradiated Teflon to produce a new resonance. Carbon monoxide alters the latter resonance to a different one while H_2 , NO, and ionized air destroy it. The resonance of the fluorocarbon radical is also nullified by H_2 and NO. When Teflon is irradiated under an atmosphere of NO gas, a triplet resonance structure apparently arising from N^{14} nuclear interaction is produced. The triplet can also be produced by admission of NO to a sample of Teflon previously irradiated in a vacuum.

538.27

5910. MILLIMETER-WAVE PARAMAGNETIC RESONANCE SPECTRUM OF ^6S STATE IMPURITY (Fe^{+++}) IN MgWO_4 .

M.Peter.

Phys. Rev., Vol. 113, No. 3, 801-3 (Feb. 1, 1959).

A broadband millimetre-wave paramagnetic resonance spectrometer was assembled. At room temperature, with a linewidth of one oersted and a time constant of one second, the least number of spins that can be detected is 2×10^{14} , in reasonable agreement with theoretical prediction. The spectrum discovered by Bowers in slightly Ni-doped MgWO_4 has been investigated and ascribed to an impurity in the ^6S state (Fe^{+++}). It is described by the spin Hamiltonian:

$$H = D[S_z^2 - \frac{1}{3}S(S+1)] + E(S_x^2 - S_y^2) + g\beta\mathbf{H}\cdot\mathbf{S},$$

with

$$S = \frac{5}{2}; D = -20.6 \text{ kMc/s}; E = +5.22 \text{ kMc/s}; g = 2.0 (T = 78^\circ\text{K}).$$

The y axis is parallel to the b axis; the z axis is turned away from the +a axis towards the +c axis by 41.5 degrees.

538.27

5911. COMPUTATION OF THE PRINCIPAL COMPONENTS OF AN ASYMMETRIC $\hat{g}$ TENSOR FROM PARAMAGNETIC RESONANCE DATA. J.E.Geusic and L.C.Brown.

Phys. Rev., Vol. 112, No. 1, 64-5 (Oct. 1, 1958).

A straightforward method is developed for obtaining the principal components of the asymmetric tensor $\hat{g}$ and its orientation in a crystal system. The necessary paramagnetic resonance data involve three crystal rotations about arbitrary orthogonal axes. Although the spin Hamiltonian is probably not applicable except for $S = \frac{1}{2}$, the development, which is based upon a calculation of the second moment of the energy levels about their mean, is quite general.

538.27

5912. CONFIGURATION COORDINATE MODEL FOR KCl:Ti INCLUDING SPIN-ORBIT INTERACTION.

F.E.Williams and P.D.Johnson.

Phys. Rev., Vol. 113, No. 1, 97-101 (Jan. 1, 1959).

The effect of the crystalline field on the spin-orbit interaction of the $^3\text{P}^0$ and $^1\text{P}^0$ states of Ti^{4+} in KCl has now been included in the configuration coordinate model. The potential energy curves for the pure spin states are required to satisfy the condition that after the application of spin-orbit interaction the resulting crystal states account for the absorption and emission spectra, explained by the earlier model, and for the oscillator strengths of the absorption bands. In accordance with the adiabatic approximation, the potential energy curves for the states involved in absorption and emission do not cross and the electronic matrix elements for radiative transitions depend on the configuration coordinate. The curve for the lower excited state has two minima which account for the 3050 Å and the 4750 Å emission bands. From the single minimum of the upper excited state an additional emission band near the 2470 Å absorption band is predicted. With intense excitation at 77°K in a narrow spectral range near 1960 Å, which corresponds to excitation only to the upper excited state, the predicted emission has been found. The existence and characteristics of the new emission provide confirmation of the model, particularly of the quantitative effect of spin-orbit interaction.

538.27

5913. ELECTRON SPIN RESONANCE IN NICKEL-DOPED GERMANIUM. G.W.Ludwig and H.H.Woodbury.

Phys. Rev., Vol. 113, No. 4, 1014-18 (Feb. 15, 1959).

Electron spin resonance absorption proportional in intensity to the Ni^{2+} concentration was detected at 14 kMc/s in germanium crystals. The spectrum, which consists of six main lines having anisotropic g values, is interpreted in terms of a Jahn-Teller distortion

of the nickel ion in any cubic direction. The principal axes of the g tensor are the cubic direction and two mutually perpendicular [110] directions having g values of 2.0294, 2.0176, and 2.1128, respectively. Hyperfine structure due to Ni^{61} in enriched samples shows the same principal axes and principal values of ≤ 1.6 , 12.2, and 10.3 respectively, in units of 10^{-4} cm^{-1} , and establishes the spin of that isotope as $\frac{3}{2}$. Hyperfine interaction with Ge^{73} in the two nearest neighbour positions toward which the nickel atom moves in the Jahn-Teller distortion was resolved and ranges from $19.8 \times 10^{-4} \text{ cm}^{-1}$ for the magnetic field in the Ni-Ge^{73} direction to $16.5 \times 10^{-4} \text{ cm}^{-1}$ at right angles to this axis. Above 20.4°K the Jahn-Teller distortion re-orientations with increasing rapidity. The line broadening and eventual merging was studied and estimates were made of the activation energies for reorientation by inversion and by rotation.

538.27 : 538.69

5914. ELECTRON RESONANCE IN AROMATIC CHROMIUM COMPLEXES. B.Elschner and S.Herzog.

Z. Naturforsch., Vol. 12a, No. 10, 860-2 (1957). In German.

Measurements and interpretation are given of the hyperfine structure in the electron spin resonance signal of $[(\text{C}_6\text{H}_5-\text{C}_6\text{H}_5)_2\text{Cr}]^{\text{I}}$ and $[(\text{C}_6\text{H}_5-\text{C}_6\text{H}_5)_2\text{Cr}]\text{Cl}$ in 0.01 molar solution in water. The spectra consist of 8 and 7 components respectively but the intensity distribution suggests the interaction of the unpaired electron on the chromium atom equally with 11 and 10 protons respectively. Spacing between adjacent components is 3.30 ± 0.15 and 3.25 ± 0.20 gauss respectively. This is interpreted to mean that the chromium atom is situated between one of the benzene rings of the biphenyl (5 protons) and the benzene ring (6 protons) in the first compound and between two benzene rings (5 + 5 protons) not on the same biphenyl in the second compound. The other protons appear not to couple significantly with the chromium. No hyperfine structure was observed for either substance dissolved in pyridine nor due to interaction with the Cr^{53} nucleus.

J.G.Powles

538.27

5915. SPIN-LATTICE RELAXATION FROM STATE OF NEGATIVE SUSCEPTIBILITY.

S.A.Collins, Jr, R.L.Kyhl and M.W.P.Strandberg.

Phys. Rev. Letters, Vol. 2, No. 3, 88-90 (Feb. 1, 1959).

A state of negative magnetic susceptibility has been demonstrated in potassium chromicyanide by using a 180° pulse technique. The spin-lattice relaxation from this state has been observed in the time domain, and the complex susceptibility shows no change in slope as it passes through zero.

538.27

5916. INVERSION OF PARAMAGNETIC RESONANCE LINES IN IRRADIATED CALCITE. J.L.Burkhardt.

Phys. Rev. Letters, Vol. 2, No. 4, 149-50 (Feb. 15, 1959).

Irradiation of calcite with 3 MeV electrons ($60 \mu \text{ coulombs/cm}^2$) produced ($\sim 10^{17}$) paramagnetic centres which have spin-lattice relaxation times of several minutes at 1.6°K. Rapid passage experiments indicate that $T_2 > 10^{-4}$ sec and the lines are 1 gauss ($\sim 10^{-7}$ sec) wide showing that they are inhomogeneously broadened. Spontaneous oscillations were observed after the populations of the levels had been inverted by rapid passage. The author also reports some measurements of the properties of the substance as a maser element.

J.M.Baker.

538.27

5917. FINE STRUCTURE, HYPERFINE STRUCTURE, AND RELAXATION TIMES OF Cr^{3+} IN TiO_2 (RUTILE).

H.J.Gerritsen, S.E.Harrison, H.R.Lewis and J.P.Wittke.

Phys. Rev. Letters, Vol. 2, No. 4, 153-5 (Feb. 15, 1959).

The electron spin resonance was observed at 23.8 and 9.52 kMc/s at room temperature, 78°K and 4.2°K. It is described by the usual spin Hamiltonian for a rhombic crystal field with parameters $g = 1.97$, $D = 0.55 \text{ cm}^{-1}$, $E = 0.27 \text{ cm}^{-1}$. For Cr^{53} the hyperfine structure parameter $A = 0.0015 \text{ cm}^{-1}$. T_2 was estimated $\sim 5 \times 10^{-9}$ sec from the line widths; and T_1 , using c.w. methods, was found to be 4×10^{-4} sec at 78°K and $\sim 4 \times 10^{-3}$ sec at 4.2°K.

J.M.Baker

538.27

5918. PARAMAGNETIC RESONANCE IN FREE RADICALS. I. DIARYL NITRIC OXIDE RADICALS.

H.E.Thom, B.E.Wahler and G.Schoffa.

Z. Naturforsch., Vol. 13a, No. 7, 552-6 (July, 1958). In German.

Electron resonance at 3 cm in eleven diaryl nitric oxide free radicals ($\text{A}_1\text{A}_2\text{NO}$ with A_1 and A_2 substituted phenyl groups) at room temperature is reported. g-values and line-widths (10-20 gauss, no structure) are given for the crystal and, in some cases, in solution.

The effect of substituents on the g-value is discussed in terms of spin-orbit coupling.

J.G.Powles

538.27 : 538.69

5919. INFRARED AND OPTICAL MASERS.

A.L.Schawlow and C.H.Townes.

Phys. Rev., Vol. 112, No. 6, 1940-9 (Dec. 15, 1958).

The extension of maser techniques to the infrared and optical region is considered. It is shown that by using a resonant cavity of centimeter dimensions, having many resonant modes, maser oscillation at these wavelengths can be achieved by pumping with reasonable amounts of incoherent light. For wavelengths much shorter than those of the ultraviolet region, maser-type amplification appears to be quite impractical. Although use of a multimode cavity is suggested, a single mode may be selected by making only the end walls highly reflecting, and defining a suitably small angular aperture. Then extremely monochromatic and coherent light is produced. The design principles are illustrated by reference to a system using potassium vapour.

538.27 : 538.69

5920. OVERHAUSER EFFECT IN COALS AND GRAPHITES.

A.Abragam, A.Landesman and J.M.Winter.

C.R. Acad. Sci. (Paris), Vol. 247, No. 21, 1852-3 (Nov. 24, 1958). In French.

Reports measurements of the Overhauser effect (saturating the electron resonance and observing an enhanced signal from protons and C^{13}) in coals and graphites arising from the A.I.S interaction, particularly in cases in which the electron resonance is exchange narrowed. In coals with narrow lines proton signal enhancement is up to 150 (theoretical value 660). In graphite the enhancement of the C^{13} resonance is 300 at room temperature and 100 at $-80^\circ C$. In this material the electron resonance could not be observed directly and was "detected" via the C^{13} resonance.

J.G.Powles

538.27 : 538.69

5921. OBSERVATION OF THE OVERHAUSER EFFECT IN A GAS IN THE PRESENCE OF A PARAMAGNETIC SOLID.

J.P.Borel and P.Cornaz.

C.R. Acad. Sci. (Paris), Vol. 247, No. 22, 1988-90 (Dec. 1, 1958). In French.

The proton magnetic resonance signal from gaseous propane (at 10 kg/cm^2) in contact with powdered diphenyl picryl hydrazyl (DPPH) at 180 kc/s is studied with simultaneous irradiation of the free radical at its electron spin resonance frequency, 118.5 Mc/s. The proton resonance signal diminishes and then grows to about seven times its initial intensity, opposite in phase, as the irradiation at 118.5 Mc/s is increased, in a manner generally in agreement with the theories of Overhauser (Abstr. 1565/1954) and Abragam (Abstr. 7255/1955).

J.G.Powles

538.27

5922. ON THE OVERHAUSER STATIONARY EFFECT IN PARAMAGNETIC SALTS AND SEMICONDUCTORS. G.R.Khutsishvili.

Nuovo Cimento, Vol. 11, No. 2, 186-97 (Jan. 16, 1959).

The expressions of the parameters f_K characterizing the degree of nuclei stationary orientation are obtained for the partial saturation of one of the hyperfine structure components in a paramagnetic salt (in case of the effective spin $\frac{1}{2}$ for the electron shell) or in silicon or in germanium with a pentavalent donor or trivalent acceptor impurity. The expressions of the parameters f_K are also obtained for the same partial saturation of all the hyperfine structure components. The contribution of the non-contact terms in the nuclei relaxation is taken into account for spin $\frac{1}{2}$. The methods for measuring the parameters f_K are also considered.

538.27 : 537.311.33

5923. RADIO-FREQUENCY ORIENTATION OF Sb^{122} . F.M.Pipkin.

Phys. Rev., Vol. 112, No. 3, 935-44 (Nov. 1, 1958).

Radioactive Sb^{122} donors in a doped silicon crystal were oriented by saturation of forbidden transitions and by the Overhauser method. Double-resonance experiments in which an electron and a nuclear transition were saturated simultaneously were used to determine the Sb^{122} hyperfine splitting. A short discussion is given of how the nuclear relaxation mechanisms affect the double-resonance orientation signals. The hyperfine splitting of Sb^{122} was found to be $-132.59 \pm 0.10 \text{ Mc/s}$ and its spin 2. The gyromagnetic ratio is -0.952 ± 0.010 .

5924. RADIOFREQUENCY SPECTROGRAPH FOR THE QUANTITATIVE STUDY OF [THE SHAPES OF] NUCLEAR MAGNETIC RESONANCE LINES IN CRYSTALS.

N.M.Aleksandrov and V.V.Moskalev.

Vestnik Leningrad. Univ., (1958), No. 16, Ser. Fiz. Khim., No. 3, 14-20. In Russian.

A device is described consisting of an electromagnet of relative field uniformity 10^{-6} and a 2-channel r.f. circuit. One channel reads amplitude and the other frequency shift at resonance with a claimed accuracy of 0.01 c/s at resonance frequency $1.4 \times 10^7 \text{ c/s}$.

C.R.S.Manders

538.27

5925. INVESTIGATIONS OF THE NUCLEAR PARAMAGNETIC RESONANCE ABSORPTION IN THE FIELD OF A CONDENSER. U.Gersch and A.Lösche.

Ann. Phys. (Leipzig), Vol. 20, No. 1-6, 167-72 (1957). In German.

The magnitude of absorption signals from a specimen placed between the plates of a condenser in a static magnetic field is considered. The use of such an arrangement in experiments where small effective h.f. fields are desired is discussed.

A.J.Manuel

538.27

5926. SPIN ECHOES.

I. THE BASIS OF NUCLEAR MAGNETIC RESONANCE. H.Winkler; II. CONSTRUCTION OF A SPIN ECHO SPECTROMETER. H.Pfeifer.

Exper. Tech. der Phys., Vol. 4, No. 6, 241-8, 248-52 (1956).

In German.

538.27

5927. ON THE QUESTION OF THE RESONANCE FREQUENCY IN NUCLEAR MAGNETIC RESONANCE EXPERIMENTS. H.Pfeifer.

Exper. Tech. der Phys., Vol. 6, No. 4, 184-90 (1958). In German.

Calculations are given of the magnetic resonance frequencies defined in various ways, for no saturation, using the Bloch equations, for (i) free precession, (ii) linear driving field, (iii) circularly polarized driving field, (iv) autodyne signals and (v) bridge signals. The deviations from the Larmor frequency are nearly always trivial.

J.G.Powles

538.27 : 538.69

5928. STEADY-STATE FREE PRECESSION IN NUCLEAR MAGNETIC RESONANCE. H.Y.Carr.

Phys. Rev., Vol. 112, No. 5, 1693-701 (Dec. 1, 1958).

A steady-state free precession technique for observing nuclear magnetic resonance is described. A mathematical analysis is presented for certain special conditions, and initial experiments verifying the results of this analysis are reported. This technique provides two opportunities for improving the signal-to-noise ratio. First, it provides a mechanism, similar to that of the "spin echo", for eliminating the effect of the inhomogeneity of the magnetic field on signal strength. This permits the effective use of larger samples. In the second place it provides a steady-state signal which can be observed with a narrow-band detector. Under certain conditions the technique has a broad response as a function of frequency or field. The upper limit to the width of this response is determined by the electronic apparatus supplying the r.f. pulses rather than the magnet or the nuclear sample.

538.27 : 338.69

5929. RADIATION DAMPING IN NUCLEAR MAGNETIC RESONANCE. A.Szöke and S.Meiboom.

Phys. Rev., Vol. 113, No. 2, 585-6 (Jan. 15, 1959).

The effect of radiation damping on nuclear magnetic resonance spectra was demonstrated experimentally. Observations on a nuclear two-level maser, obtained by flipping the magnetization through about 180 degrees, are reported.

538.27 : 538.69

5930. SATURATION THEORY IN MAGNETIC NUCLEAR RESONANCE. G.Vojta.

Z. Naturforsch., Vol. 12a, No. 4, 282-94 (1957). In German.

In order to carry out a theoretical study of saturation phenomena the author derives a general equation of motion for the quantum-statistical density matrix of a nuclear-spin system, and solves it for the steady-state condition; more complicated cases have not yet been taken into consideration, e.g. those with quadrupole relaxation and line structures by spin-spin interaction. The real

and imaginary parts of h.f. susceptibility of the nuclear-spin system are obtained. The cases of both equal and unequal relaxation times have been dealt with, the solutions being valid for any field intensities of the constant and h.f. magnetic field.

F.Lachman

538.27 : 538.69

5931. ON THE DETECTION OF NUCLEAR MAGNETIC RESONANCE WITH MARGINAL OSCILLATORS (AUTODYNES). H.Pfeifer. *Exper. Tech. der Phys.*, Vol. 2, No. 3, 127-8 (1954). In German.

An analysis of the operation of the autodyne type detector of magnetic resonance allowing for both the loading and "pulling" due to the resonant magnetism of the sample. Distortion from the true line shape and eventually instability may occur as the magnetic resonance line becomes narrower.

J.G.Powles

538.27 : 538.69

5932. THE EFFECT OF FIELD INHOMOGENEITY ON THE NUCLEAR RESONANCE ABSORPTION SIGNAL. U.Dolega. *Exper. Tech. der Phys.*, Vol. 2, No. 1, 22-7 (Jan., 1954). In German.

The effect of inhomogeneity of the static magnetic field on the nuclear resonance absorption signal is investigated theoretically on the basis of the Bloch equations for a cylindrical sample under both slow and fast passage conditions. Some experimental confirmation of the results is given.

J.G.Powles

538.27 : 538.69

5933. THE STRUCTURE OF NUCLEAR INDUCTION SIGNALS. A.Lösche. *Fortschr. Phys.*, Vol. 6, No. 7-8, 335-74 (1958). In German.

A review of nuclear magnetic resonance effects including, the Bloch equations; dipole-dipole interaction in crystals; calculation of line moments for two, three and four spin systems; absorption in liquids; chemical shift and indirect spin-spin coupling. About 100 references.

J.G.Powles

538.27 : 538.69

5934. THE BLOCH-SIEGERT EFFECT AND THE EFFECT OF A PERTURBING ALTERNATING FIELD ON MAGNETIC AND QUADRUPOLE RESONANCE. F.Lurçat. *J. Phys. Radium*, Vol. 19, No. 10, 745-9 (Oct., 1958). In French.

A method is given, which allows the study of the resonance frequency shift due to finite radiofrequency field amplitude, or to another field with a different frequency — starting from macroscopic equations. This method is applied to the computation of these shifts, in the case of quadrupole resonance of nuclei with spins 1, 3/2 and 5/2.

538.27 : 538.69

5935. SPIN EXCHANGE AND SPIN-LATTICE RELAXATION INDUCED BY MECHANICAL ROTATION OF SOLIDS. D.E.Woessner and H.S.Gutowsky.

J. chem. Phys., Vol. 29, No. 4, 804-12 (Oct., 1958).

Measurements with spin-echo apparatus have shown that mechanical rotation of a sample in the static magnetic field decreases the proton T_1 in solid chlorobenzenes for particular proton magnetic resonance frequencies within the range 23.2-41 Mc/s. The results are explained by the following model: magnetic coupling between protons and lattice is weak while the quadrupolar coupling of chlorine nuclei with the lattice is strong. Upon rotation of the sample, the angular dependence of the Zeeman splitting of the chlorine quadrupole levels enables the chlorine resonance frequencies to be brought into coincidence with that of the protons. The resulting spin exchange and energy transfer between protons and chlorine nuclei provides an indirect but nonetheless effective thermal contact of protons with the lattice, thereby reducing the proton T_1 . The general question of anomalies in the dependence of T_1 upon resonance frequency is discussed briefly.

538.27 : 538.69

5936. A SYNCHRONIZED AUTODYNE DETECTOR AND ITS USE IN THE STABILIZATION OF MAGNETIC FIELDS WITH PROTON RESONANCE. W.Müller-Warmuth and P.Servoz-Gavin. *Z. Naturforsch.*, Vol. 13a, No. 3, 194-203 (March, 1958). In German.

The behaviour of an autodyne nuclear magnetic resonance detector, when coupled to a synchronizing oscillator of standard frequency, is investigated using the theory of van der Pol. For strong coupling the free oscillations are suppressed and the apparatus acts as a modified Q-meter detector. For weak coupling free oscillations occur, synchronized to the standard frequency, and the circuit behaves as a synchronized autodyne detector. The sensitivity and signal-noise ratio for this circuit are discussed. A magnetic field stabilizer with a long term stability of 1 part in 10^6 is described.

A.J.Manuel

5937. PROTON MAGNETIC RESONANCE SPECTRA IN TRICHLORACETIC ACID. M.Goldman.

J. Phys. Chem. Solids, Vol. 7, No. 2-3, 165-9 (Nov., 1958). In French.

Proton magnetic resonance spectra were observed for both monocrystalline and polycrystalline samples of trichloroacetic acid. They provide evidence that the acid is a dimer with a proton-proton distance of 2.56 ± 0.02 Å. The spectrum of the single crystal was studied as a function of orientation in the magnetic field and indicates the presence of two orientations of the proton-proton vector in the crystal, inclined at an angle of $31^\circ \pm 30'$. A γ -irradiated polycrystalline sample was investigated at room temperature and the temperature of liquid nitrogen, and a comparison of the spin-lattice relaxation times suggests that the C-Cl₃ groups are rotating at room temperature.

538.27 : 538.69

5938. ON THE T_1/T_2 RATIO FOR PROTONS IN AQUEOUS Mn^{++} SOLUTIONS. J.King and N.Davidson.

J. chem. Phys., Vol. 29, No. 4, 787-91 (Oct., 1958).

The $T_1 \neq T_2$ anomaly for water protons in solutions containing Mn^{++} has been investigated. At 40 Mc/s (proton frequency), $T_1/T_2 = 9.5(\pm 0.5)$ for Mn^{++} solutions. When the Mn^{++} is complexed by the hexadentate ligand, ethylenediaminetetraacetate (MnY^{-4}), or by the tetradentate ligand, nitrilotriacetate (MnX^{-3}), T_1 is increased slightly and T_2 is increased markedly, so that $T_1 = T_2$ and the anomaly disappears. For MnX^{-3} , there are probably still 2 H_2O molecules complexed to Mn^{++} . Electron paramagnetic resonance studies show that the paramagnetic relaxation time is reduced by complexing (from 3×10^{-9} sec for Mn^{++} to 3×10^{-10} sec for MnX^{-3}). The results therefore support the suggestion by Bloembergen that the anomalous T_2 broadening is caused by an A-I-S coupling between the electron spin, S, of Mn^{++} and the proton spins, I, in the coordination sphere plus a long paramagnetic relaxation time. All features of the variation of T_1 and T_2 with frequency are explained rather well by consideration of the combined effects of the I-S interaction and the dipole interaction.

538.27

5939. PROTON RESONANCE SHIFTS FOR THE SYSTEMS HNO_3-H_2O AND HNO_3-KNO_3 . J.A.Happe and A.G.Whittaker. *J. chem. Phys.*, Vol. 30, No. 2, 417-21 (Feb., 1959).

Proton resonance shifts were measured for the concentrated region of the nitric acid-water system and also for the system nitric acid- KNO_3 . The nitrate ion is very effective in unshielding the protons of nitric acid and further information is presented on the solvation of this ion in the anhydrous acid. Chemical shifts in nitric acid-water solutions are interpreted in terms of the associated nature of nitric acid. The effect of the self-ionization of anhydrous nitric acid on the chemical shift for this liquid is evaluated. Also, it was found that the chemical shift could be used for very accurate analysis of nitric acid-water mixtures in the concentrated acid region.

538.27 : 538.69

5940. ASYMMETRY OF PROTON RESONANCE SIGNALS IN SOME HYDRATES OF IRON GROUP SALTS. S.Yano, S.Sasaki and T.Sidei.

J. Phys. Soc. Japan, Vol. 13, No. 2, 227-8 (Feb., 1958).

The resonances in powdered samples at room temperature showed an asymmetric structure which was field-dependent and which was nearly in agreement with the theory for a pair of nuclear spins in the field due to the electronic spin of a magnetic ion.

E.F.W.Seymour

538.27 : 538.69 : 539.19

5941. DETERMINING MOLECULAR STRUCTURE BY NUCLEAR MAGNETIC RESONANCE OF HYDROGEN. N.F.Chamberlain. *Analyt. Chem.*, Vol. 31, No. 1, 56-77 (Jan., 1959).

A method is presented for rapid and accurate determination of important features of the molecular structure of hydrocarbons and their derivatives, for either pure compounds or mixtures of compounds. This technique has been developed from a detailed study of the spectra of over 400 pure compounds obtained under standardized and reproducible conditions. The chemical shift information is summarized in a series of charts. This technique has saved many hours in petroleum research, in that a variety of organic functional groups under a wide variety of conditions can be identified quickly and positively without precise calibration with the exact compounds being studied. It has been used to identify the starting compounds,

reaction intermediates, and products in organic chemical research problems, and to characterize petroleum hydrocarbon mixtures. This technique should add substantially to the knowledge of the structure of complex organic compounds.

5942. ISOTROPIC NUCLEAR RESONANCE SHIFTS.

H.M.McConnell and R.E.Robertson.

J. chem. Phys., Vol. 29, No. 6, 1361-5 (Dec., 1958).

It is shown that isotropic (or average) nuclear resonance shifts for a nucleus in a paramagnetic molecule in solution, and in a polycrystalline solid, can be used to distinguish between Fermi contact and "pseudocontact" contributions to isotropic nuclear-hyperfine interactions. The pseudocontact interaction is that isotropic hyperfine coupling which arises from the combined effects of (electron-spin)-(nuclear-spin) coupling, (electron-orbit)-(nuclear-spin) coupling, and electron spin-orbit interaction. When the magnetic hyperfine interaction between the electronic moment and nuclear spin is approximated by a point dipolar interaction, and the isotropic hyperfine interaction is exclusively pseudocontact, then the isotropic nuclear shift in a polycrystalline solid exceeds the solution shift by the factor $3(g_{\parallel} + g_{\perp})/(g_{\parallel} + 2g_{\perp})$ where $g_{\parallel}$ and $g_{\perp}$ are the spectroscopic splitting factors parallel and perpendicular to the molecular symmetry axis. Isotropic shifts due to the Fermi contact interaction are the same for both solid state and solution cases.

5943. NUCLEAR ALIGNMENT IN LIQUID AND SOLID ^3He .

W.M.Fairbank and G.K.Walters.

Nuovo Cimento Suppl., Vol. 9, No. 1, 297-305 (1958).

The magnetic susceptibility of He^3 is measured by the way of the intensity of the nuclear resonance signal. It is found that the temperature-susceptibility curve is very similar to that expected for a perfect gas but spin alignment occurs at much lower temperatures and the low-temperature susceptibility is very much larger than the corresponding gas model would imply. Experiments with the liquid at pressures of 11 and 28 atm and with solid He^3 yield temperature-susceptibility curves similar to the above but alignment begins at lower temperatures. In another series of experiments the spin lattice relaxation time of solid and liquid He^3 is measured; hence an estimate of the order of magnitude of the self-diffusion coefficient and also a rough determination of the melting curve are made. Experiments with liquid mixtures of the helium isotopes show a phase separation. The phase diagram is obtained over a wide range of concentrations.

5944. MAGNETIC RESONANCE LINE SHAPES AT THE ONSET OF SATURATION. D.F.Holcomb.

Phys. Rev., Vol. 112, No. 5, 1599-603 (Dec. 1, 1958).

Magnetic resonance absorption line shapes and widths in Li metal and CaF_2 crystals were measured as a function of radio-frequency power level. The measurements were made on the Li^7 resonance in Li at 77°K and 215°K and on the F^{19} resonance in CaF_2 at room temperature. The measurements were made from low r.f. power into the region of appreciable saturation, but not into the very high saturation region considered by Redfield. A decrease in δH , the peak-to-peak absorption derivative line-width, was observed in both systems at sufficiently large values of H_1 , the r.f. magnetic field. The changes of line-width in Li at various values of T_1 and of characteristic motional frequency of the nuclei show good qualitative agreement with the criteria proposed in the recent theory of Tomita. Line-width data obtained by Redfield in aluminium are included for comparison. In the case of CaF_2 , where the spin-lattice relaxation proceeds via paramagnetic impurities, the decrease in δH occurs at appreciably higher saturation levels than is the case in Li and Al.

5945. NUCLEAR MAGNETIC RESONANCE EXPERIMENTS OF I^{127} IN KI. J.Itoh and Y.Yamagata.

J. Phys. Soc. Japan, Vol. 13, No. 10, 1232-3 (Oct., 1958).

The variation of the spin lattice relaxation time, and of the chemical shift, of the iodine nuclear resonance in KI has been measured as a function of temperature. The absolute values of these quantities can be interpreted if a covalent degree of about 5% is assumed in each bond between K^+ and I^- . The existing theories give a fair fit at low temperatures, but there are unexplained deviations from their predictions at higher temperatures.

5946. NUCLEAR MAGNETIC RESONANCE STUDIES OF DOPED III-V COMPOUNDS. E.H.Rhoderick.

J. Phys. Chem. Solids, Vol. 8, 498-504 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The dominant effect of impurities on the magnetic resonance of the host nuclei in III-V compounds consists of broadening brought about by the interaction of the nuclear quadrupole moments with inhomogeneous electric fields. These electric fields may be either the Coulomb fields associated with ionized impurities or the distortions of the crystalline field caused by the elastic strains around neutral imperfections. In both cases, the interaction is strong enough for $\sim 10^3$ or more nuclei around each impurity atom to be affected, so that the significance of the lattice structure disappears, and information about the immediate vicinity of the imperfection is not directly obtainable. In spite of this, there are cases in which the magnitude of the broadening, in conjunction with Hall effect measurements, yields qualitative information about the type of imperfection involved. For example, nuclear resonance shows that Si atoms enter the GaAs lattice in two forms, one of which acts as a donor while the other is electrically neutral.

5947. DIRECT OBSERVATION OF THE H.F.S. OF A PARAMAGNETIC ION IN AN ANTIFERROMAGNET. NUCLEAR MAGNETIC RESONANCE OF Co^{59} IN CoF_2 . V.Jaccarino.

Phys. Rev. Letters, Vol. 2, No. 4, 163-5 (Feb. 15, 1959).

The resonance was observed between 160 and 190 Mc/s in fields up to 10^4 Oe and at temperatures between 1.3 and 4.2°K . Because of quadrupole interaction, seven lines were observed each split into two by the external field. Values were derived for the magnetic hyperfine interaction constant and the quadrupole interaction constant (the value of $Q(\text{Co}^{59})$ being unknown). Certain difficulties in interpretation are mentioned.

PROTON MAGNETIC RESONANCE IN POLYISOBUTYLENE AT VARIOUS TEMPERATURES, PRESSURES, AND FREQUENCIES. See Abstr. 3985

5948. NUCLEAR MAGNETIC RESONANCE SPECTRA FROM A CRYSTAL ROTATED AT HIGH SPEED.

E.R.Andrew, A.Bradbury and R.G.Eades.

Nature (London), Vol. 182, 1659 (Dec. 13, 1958).

The Na^{23} magnetic resonance line in NaCl is observed while the crystal is rotated about its [001] direction which is lying perpendicular to the applied magnetic field, at frequencies up to 800 c/s. It is observed that "sideband" resonances appear at even multiples of the rotation frequency on either side of the line centre. However, the second moment (mean square width) of the absorption line remains constant. This is therefore a direct example of "motional narrowing" of a nuclear resonance signal and of the invariance of the second moment to motion.

5949. NUCLEAR MAGNETIC RESONANCE IN CERIOUS MAGNESIUM NITRATE AT TEMPERATURES BELOW 1°K .

T.L.Estle, H.R.Hart, Jr and J.C.Wheatley.

Phys. Rev., Vol. 112, No. 5, 1576-86 (Dec. 1, 1958).

The nuclear resonance of the protons in cerous magnesium nitrate, $\text{Ce}_2\text{Mg}_3(\text{NO}_3)_{12} \cdot 24\text{H}_2\text{O}$, was studied in a single crystal cooled to temperatures below 1°K by partial adiabatic demagnetization and adiabatic rotation. The area under the nuclear resonance was used as a thermometric parameter. The area did not obey Curie's law as a result of the temperature-dependent local r.f. field. A $T-T^*$ relation was derived which gave temperature ratios on adiabatic rotation which agreed within 5-10% with ratios calculated from the properties of the crystal. The lowest measured temperature was $5 \times 10^{-3}^\circ\text{K}$. A study of the structure of the resonance showed that the splittings were caused by the average magnetization of the cerium ions and that the protons were at least 5 Å from the cerium ions.

5950. NUCLEAR SPIN SATURATION BY ULTRASONICS IN SODIUM CHLORIDE. E.F.Taylor and N.Bloembergen.

Phys. Rev., Vol. 113, No. 2, 431-8 (Jan. 15, 1959).

An ultrasonic vibrational mode with rather well-defined properties was set up in a cylindrical single crystal of sodium chloride. The saturation of the spin levels of Na^{23} and Cl^{35} by acoustically induced quadrupole transitions, $\Delta m = \pm 2$, was measured

in the steady state by a standard nuclear magnetic resonance technique, for several orientations of the ultrasonic wave and external magnetic fields. The components of the fourth-order tensor connecting the electrical field gradient tensor at the nuclei with the strain deformation tensor have been determined. The components satisfy an isotropy condition rather than the Cauchy relation. The results show the inadequacy of the ionic point-charge model coupled with an isotropic Sternheimer antishielding factor. The interpretation of the data requires a considerable amount of covalent character and configurational interaction on the Na^+ ion.

538.27 : 538.69 : 532.7

NUCLEAR RELAXATION IN LIQUIDS AT VARIOUS TEMPERATURES. See Abstr. 4344

538.27 : 538.69

5951. A CONTRIBUTION TO THE STUDY OF IMPERFECTIONS IN SOLIDS BY MEANS OF NUCLEAR QUADRUPOLE RESONANCE. B. Dreyfus.

Ann. Phys. (Paris), Vol. 3, No. 9-10, 683-738 (Sept.-Oct., 1958). In French.

A thesis containing mainly a study of the Br^{79} pure quadrupole resonance at 270 Mc/s in p-dibromobenzene in solid solution in p-dichlorobenzene, p-chlorobromobenzene and p-iodobenzene. The results are interpreted in terms of thermal motions of the molecules and particularly the effect on these of the "impurities". Changes in the electric field gradients in the crystal are studied via the line width changes with temperature and the intensity changes with concentration of the solutions. The effect of grinding crystals of p-dibromobenzene on the resonance is studied in terms of the crystal imperfections and internal strains produced. The material recovers exponentially with the time and this process is discussed.

J.G. Powles

538.27

5952. NUCLEAR MAGNETIC RESONANCE ABSORPTION IN GLASS. I. NUCLEAR QUADRUPOLE EFFECTS IN BORON OXIDE, SODA-BORIC OXIDE, AND BOROSILICATE GLASSES. A.H. Silver and P.J. Bray.

J. chem. Phys., Vol. 29, No. 5, 984-90 (Nov., 1958).

The nuclear magnetic resonance spectrum of B^{11} was investigated in several glassy materials containing boron oxide. A value of 2.76 ± 0.05 Mc/s for the nuclear quadrupole coupling constant of B^{11} has been calculated from the second-order quadrupole perturbation of the $m = \frac{1}{2} \rightarrow -\frac{1}{2}$ resonance line. The same quadrupole interaction has been observed in pure boron oxide, B_2O_3 soda-boric oxide binary glasses, and two commercial borosilicate glasses. The quadrupole coupling constant is interpreted as arising from the bonding electrons in BO_3 groups which comprise the glass network in boron oxide. Addition of oxygen ions to the glass network induces a change in the boron configuration from BO_3 planar groups to BO_4 tetrahedra resulting in a reduction in the quadrupole interaction. This effect has been observed in the $\text{Na}_2\text{O}-\text{B}_2\text{O}_3$ glasses and in Corning "Pyrex" and 707 borosilicate glasses.

538.27

5953. ZEEMAN QUADRUPOLE SPECTRUM OF CYANURIC CHLORIDE. F.J. Adrian.

J. chem. Phys., Vol. 29, No. 6, 1381-5 (Dec., 1958).

The Zeeman splitting of the Cl^{35} pure quadrupole resonances in cyanuric chloride was studied. Location of the principal electric field gradient axes demonstrated that cyanuric chloride is a planar molecule, with a threefold rotation axis perpendicular to the molecular plane. The planar molecules all lie in the (1, 0, 1) planes of the monoclinic crystal. It seems likely that the molecules are oriented within these planes so that each molecule has a carbon-chlorine bond lying along the b crystallographic axis. The field gradient asymmetry parameter is 0.24 for all the Cl atoms. This result is interpreted in terms of the effect of the ring nitrogens on the double-bond character of the carbon-chlorine bond.

538.27 : 538.69

5954. MACROSCOPIC EQUATIONS OF QUADRUPOLE RESONANCE. F. Lurcat.

J. Phys. Radium, Vol. 19, No. 8-9, 713-23 (Aug.-Sept., 1958). In French.

Equations are given for quadrupole resonance, analogous to Bloch's equations for magnetic resonance. These equations allow induction and echo phenomena in quadrupole resonance to be studied. The degree of approximation of the equations of Bloom, Hahn and Herzog is discussed.

5955. PRECISE DETERMINATION OF NUCLEAR QUADRUPOLE RESONANCE LINE OF SOLID IODINE. A. Shimauchi.

Sci. of Light (Tokyo), Vol. 6, No. 2, 58-68 (Aug., 1957).

The temperature variations of the pure quadrupole coupling constant, eQq_{zz} , and asymmetry parameter, η , of I^{127} in solid iodine were determined by simultaneous measurement of two resonance frequencies corresponding to the transitions $m_z = \pm \frac{1}{2} \leftrightarrow \pm \frac{3}{2}$ and $m_z = \pm \frac{3}{2} \leftrightarrow \pm \frac{5}{2}$. Two oscillators were connected with each other by the sample, and signals of the two resonance frequencies were detected by superregenerative detection at the same time. Errors arising from the heating of the sample by several processes, related to the character of the oscillator and sample, are completely eliminated by the method used. The results suggest that the variations of eQq_{zz} and η should be expressed in terms of the first resonance frequency, ν_1 , rather than the apparent temperature. The second resonance frequency, ν_2 , has a maximum at 290°K of value 644.42 Mc/s and cannot be used as a measure of temperature. The asymmetry parameter is a steadily decreasing function of the temperature, and eQq_{zz} has a maximum at 200°K of value 2158.3 Mc/s. This curve is analysed considering the effect of asymmetry parameter, and the calculated values of eQq_0 , for an isolated I_2 molecule, decrease normally with temperature. These final curves can be explained qualitatively by the thermal vibrations of molecules in the crystal.

538.27

5956. THE NUCLEAR QUADRUPOLE RESONANCE SPECTRA OF BROMOBENZENE AND OF 1,2-DIBROMOETHANE. W. Zeil and A. Schmitt.

Z. Naturforsch., Vol. 13a, No. 3, 241-3 (March, 1958). In German.

The signal to noise ratio and frequency for the quadrupole resonance of Br^{79} in bromobenzene dissolved in benzene were investigated at liquid air temperature. No variation of resonance frequency was observed up to 10 mol% benzene when the signal was suppressed by noise. For 1,2-dibromoethane a third line in addition to the two already observed by other workers was obtained for both Br^{79} and Br^{81} , when the substance was rapidly frozen. This additional line was 0.2 of the intensity of the two main lines. For 1,2-dibromoethane dissolved in benzene the two strong lines were observed with only 20 mol% 1,2-dibromoethane but the weak line disappeared for less than 50 mol%.

A.J. Manuel

ELECTROMAGNETISM MAGNETOHYDRODYNAMICS

538.3 : 537.57

5957. THE DIFFUSION OF MAGNETIC FIELDS IN A CYLINDRICAL CONDUCTOR. J.H. Adlam and R.J. Tayler.

Atomic Energy Res. Establ. (Harwell) Rep. T/M160, 12 pp. (1958).

The conventional stabilized pinched discharge requires axial and azimuthal magnetic fields which are to a high degree separated. The finite electrical conductivity of the discharge causes these fields to diffuse into one another. The (simple) present discussion states that significant field-mixing occurs in an electromagnetic penetration time τ determined by the relevant electrical conductivity. It is also shown what fraction of τ is important in stability problems. By regarding the discharge as an incompressible fluid of uniform conductivity, sufficient field diffusion to lead to loss of stability can occur in times of the order of $10^{-3} \tau$.

538.3 : 532.5

MAGNETOHYDRODYNAMICS. BIBLIOGRAPHICAL SURVEY. See Abstr. 5397

538.3 : 532.5 : 523.161

5958. ON THE EQUILIBRIUM CONFIGURATIONS OF PROLATE FLUID SPHEROIDS UNDER THE INFLUENCE OF A UNIFORM EXTERNAL MAGNETIC FIELD. S.P. Talwar.

Z. Astrophys., Vol. 42, No. 1, 42-7 (1957).

The problem of the gravitational stability of non-magnetic prolate fluid spheroidal masses of infinite electrical conductivity is studied under the influence of a uniform external magnetic field. A sequence of prolate spheroids of equilibrium is shown to exist. Further, it is found that the effect of the external magnetic field is to deshape them into thin rod-like shapes, the effect being much more pronounced in smaller and less dense clouds.

538.3 : 532.5 : 523.852

5959. THE INFLUENCE OF A MAGNETIC FIELD ON THE LONGITUDINAL STABILITY OF A GRAVITATING CYLINDER. F.C.Auluck and D.S.Kothari.

Z. Astrophys., Vol. 42, No. 2, 101-13 (1957).

The paper deals with the problem of the longitudinal stability of an infinitely long gravitating cylinder subject to the influence of a magnetic field; the material is assumed to be incompressible, inviscid and infinitely conducting. The cases of current-distribution inside the cylinder giving poloidal and toroidal fields are considered. The case of a uniform field (H_z) inside the cylinder and a uniform field (H_z) outside it is also described. The general conclusion is that in every case the magnetic field increases the stability of the cylinder.

ELECTROMAGNETIC WAVES AND OSCILLATIONS

538.561 : 621.375.9

5960. THE PHYSICAL PRINCIPLES OF A NEGATIVE-MASS AMPLIFIER. H.Krümer.

Proc. Inst. Radio Engrs., Vol. 47, No. 3, 397-406 (March, 1959).

See also Abstr. 4167 (1958). By providing in a crystal, carriers of such an energy and such a momentum that at least one of their three main effective masses is negative, it should be possible to obtain wave amplification in such a crystal. The amplifier should work up to about 1000 kMc/s (0.3 mm wavelength), with a large bandwidth. To obtain carriers of sufficient energy and proper momentum, acceleration by a high field seems most feasible at present. Negative effective masses for relatively low energies may be obtained if the energy contours are re-entrant near the band edge, as is the case for the heavy holes in germanium and, as may be the case for other semiconductors with degenerate band edges. The optical-phonon collision cross-section should also be high in order to obtain sufficient concentration in k -space. If the latter is the case for germanium a verifiable microwave amplifier using the principle would consist of a wafer of p -type germanium with a strong bias field applied in a crystallographic (100) direction, and inserted into a waveguide or a cavity such that the electric vector of the microwave field is perpendicular to the bias field. Such a bulk amplifier has no critical dimensions, receives its power from a d.c. battery, and has essentially no frequency dependence over the entire radio spectrum. The principle is not restricted to germanium, but should also work with certain other semiconductors. Low-frequency amplifiers and bistable devices are also possible. Some design problems are discussed.

538.566

5961. KINEMATICS OF GROWING WAVES. P.A.Sturrock.

Phys. Rev., Vol. 112, No. 5, 1488-503 (Dec. 1, 1958).

This paper is concerned with the problem of distinguishing between amplifying and evanescent waves. These have, in the past, been distinguished by considerations of energy transfer or of the initial and boundary conditions with which a wave must be associated. Both procedures are open to criticism. The problem is here interpreted kinematically: the author investigates the classes of wave-functions which a given propagating system may support, without inquiring into the way these disturbances may be set up, and postponing inquiry into the boundary conditions necessary. In this way, one may distinguish between amplifying and evanescent waves by determining whether a wave-function which may be analysed into "real-frequency" waves may also be analysed into "real-wave-number" waves. This question may be answered by means of a certain diagram, which may be constructed from knowledge of the dispersion relation. Interchange of the roles of time and space leads to the statement and solution of a further problem. If a propagating system is unstable, the instability may be such that a disturbance grows, but is propagated away from the point of origin: this is termed "convective instability". On the other hand, the instability may be such that the disturbance grows in amplitude and in extent, but always embraces the original point of origin: this is termed "nonconvective instability". The statement that the system supports amplifying waves is synonymous with the statement that the system exhibits convective instability. A system which exhibits nonconvective instability may not be used as an amplifier, but may be used as an oscillator. It is possible to distinguish between convective and nonconvective instability by a further diagram which also may be constructed from knowledge of the dispersion relation. This theory enables the following assertions to be made. If

ω is real for all real k , then any complex k , for real ω , denotes an evanescent wave. Conversely, if k is real for all real ω , then any complex ω , for real k , denotes nonconvective instability. The theory is illustrated by certain simple examples and by discussion of the result of weak coupling between certain types of waves.

538.566 : 537.56

WAVE PROPAGATION IN A "PLASMA CABLE" WITH EXTERNAL MAGNETIC FIELD. See Abstr. 5839

538.566

5962. STUDY OF THE DETAILED STRUCTURE OF THE CURVES FOR SCATTERING OF ELECTROMAGNETIC WAVES BY DIELECTRIC SPHERES. J.Mevel.

J. Phys. Radium, Vol. 19, No. 7, 630-6 (July, 1958). In French.

Recent theoretical computations of the light extinction curve by dielectric spheres have shown that it has, superposed on the major oscillations, very rapid fluctuations of small amplitude: this feature has not been explained. In this paper it is shown that these fluctuations result from resonances of multipole terms which form the scattered radiation, and the origin of each of these secondary maxima is elucidated. A new theorem is presented which gives the amplitude of the multipole modes, and from this, the positions and intensities of the detailed structure are computed. Finally it is shown that the present known extinction curve is not correct and the manner in which it must be modified is indicated.

538.566

5963. ON THE INCLUSION OF THE EFFECT OF THE THICKNESS OF THE SCREEN IN CERTAIN DIFFRACTION PROBLEMS. A.N.Akhiezer.

Zh. tekhn. Fiz., Vol. 27, No. 6, 1294-300 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 6, 1190-6 (June, 1957).

Describes the generalization of Bethe's quasistatic theory of diffraction at small apertures in a plane ideally conducting screen to the case of a screen of finite thickness. The case of magnetic coupling is considered. The corresponding boundary-value problem of potential theory reduces to two independent integral equations, which are solved approximately. The solution obtained is applied to the problem of the coupling of two waveguide through an aperture in a common wall. A comparison with experiment is carried out.

538.566

5964. A NEW METHOD FOR SOLVING PROBLEMS RELATED TO THE DIFFRACTION OF ELECTROMAGNETIC WAVES BY A PLANE [SCREEN] WITH AN UNBOUNDED STRAIGHT SLIT. G.A.Grinberg.

Zh. tekhn. Fiz., Vol. 27, No. 11, 2595-605 (1957). In Russian. English translation in Soviet Physics — Technical Physics (New York), Vol. 2, No. 11, 2410-19 (Nov., 1957).

Based on the consideration of the current which the external field induces on the shaded side of the screen. This makes it possible to reduce the problem to the solution of structurally simple Fredholm equations of the second kind, from which, in particular, one easily obtains the asymptotic form of the solution for wavelengths that are small compared with the slit width. The example of normal incidence of a plane wave on a slit is used to show that this asymptotic form can give a very good approximation to the exact solution, not only when the incident wavelength is much less than the slit width, but even when these two dimensions are equal. The method is applied also to find a new form of the solution for diffraction by a semi-infinite plane.

538.566

5965. PROPAGATION OF GUIDED ELECTROMAGNETIC WAVES IN A GYROELECTRIC ELECTRON PLASMA.

B.Unal and T.Kahan.

J. Phys. Radium, Vol. 19, No. 7, 637-8 (July, 1958). In French.

A partial differential equation of the fourth order is derived which describes the electromagnetic wave propagation in a wave guide filled with a magneto plasma.

538.566.2

5966. GROUP VELOCITY OF DAMPED WAVES. L.A.Vainshtein.

Zh. tekhn. Fiz., Vol. 27, No. 11, 2606-14 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York)

Vol. 2, No. 11, 2420-8 (Nov., 1957).

The group velocity is defined as the velocity of the "centre-of-energy" of a quasi-monochromatic signal; this definition is useful for absorbing media, in which signals are deformed while propagating. According to this definition the group velocity is found to be

$\bar{S}_z/w$, where $\bar{S}_z$ is the component of the Poynting vector along the direction of propagation of the plane wave, and w is the energy density. The energy density and group velocity are calculated for a medium with the simplest material properties (where the field satisfies the standard telegraph equations), for a plasma, and for a dielectric with elastically bound electrons.

538.566.2 : 535.43 : 530.19

PENETRATION OF RADIATION IN NATURAL SCATTERING MEDIA. See Abstr. 5388

538.566.3

5967. THE IONOSPHERIC FARADAY EFFECT AND ITS APPLICATIONS. F.B.Daniels and S.J.Bauer. J. Franklin Inst., Vol. 267, No. 3, 187-200 (March, 1959).

Theory outlined. Measurements of ionospheric characteristics by means of lunar radio reflections and radio transmissions from artificial satellites utilizing this effect are discussed. The rate of fading of satellite signals due to the Faraday effect is found to depend upon both the integrated electron density up to the height of the satellite and the local electron density at the satellite. Thus, a possibility exists of determining both quantities provided the satellite transmissions are received simultaneously by two or more stations. Expressions for the fading rate are derived and the effects of orbital parameters on the determination of ionospheric characteristics are discussed.

NUCLEAR AND ATOMIC PHYSICS APPARATUS . PARTICLE DETECTORS

539.1.07

5968. A NEW TYPE OF PARTICLE DETECTOR: THE "DISCHARGE CHAMBER". S.Fukui and S.Miyamoto. Nuovo Cimento, Vol. 11, No. 1, 113-15 (Jan. 1, 1959).

Describes briefly a new type of detector based on gaseous discharges. It consists of a glass box with metal or conductive glass plates as electrodes, filled with a mixture of neon and argon at atmospheric pressure. A triggered pulsed field of the order of 14 kV per 2 cm and of 10^{-7} sec time constant is applied immediately after passage of ionizing particle, causing small luminous discharges along the trajectory, which can be photographed. Simplicity of construction suggests its use for cosmic rays and with accelerators, especially as it can detect many particles simultaneously.

J.M.Zarzycki

539.1.07

5969. MEASUREMENTS ON THE TEMPORAL DISCHARGE SPREAD IN GEIGER-MÜLLER COUNTER TUBES AND THEIR APPLICATION TO THE REPRESENTATION OF RADIOACTIVE RADIATION FIELDS. P.Kienle. Z. Naturforsch., Vol. 13a, No. 1, 37-47 (Jan., 1958). In German.

Describes the apparatus used for an experimental determination, by two different methods, of the time taken for a discharge initiated by radiation in a given region of one counter, to spread to another enclosed in the same envelope. The results show that there is very little statistical fluctuation in the time taken for the discharge to spread a given distance, and thus such a counter device may be used to locate sources of radiation accurately. An arrangement for mapping radioactive radiation fields in this way is described, and applications to radio-chromatography and medicine are discussed. It is concluded from the results that the discharge spreads by photo-ionization of the quenching gas by strongly absorbed photons from the avalanche.

J.Dutton

539.1.07 : 537.533

PROBLEM OF THE MEASUREMENT OF THERMALLY STIMULATED CO-ELECTRON EMISSION OF EXO-ELECTRONS WITH THE USE OF SPARK COUNTERS DURING LOSS OF WATER OF CRYSTALLIZATION. See Abstr. 5795

539.1.07 : 537.533.2 : 621.383.27

5970. PRESENT STATUS OF SCINTILLATION COUNTER DEVELOPMENT IN FRANCE. J.Labeyrie.

I.R.E. Trans Nuclear Sci., Vol. NS-5, No. 3, 212-14 (Dec., 1958).

Some properties (such as background linearity at high currents, transit-time fluctuations, and stability for β counting) of different types of photomultiplier which are now in commercial use in France are discussed. In addition, some properties of different types of

scintillator in commercial use or under development are presented. These properties include amplitude, light spectrum and decay-time temperature for various mineral or organic (solid and liquid) scintillators, and of several gaseous mixtures. Brief descriptions are given of two new French applications of scintillation techniques: gamma spectrometer for aerial prospecting and the measurement of thermal neutron fluxes in reactors.

539.1.07

5971. CONTINUOUS MEASUREMENT OF WEAK β RAYS IN LIQUIDS WITH A SCINTILLATION TUBE.

K.H.Kimbel and J.Willenbrink.

Naturwissenschaften, Vol. 45, No. 23, 567 (1958). In German.

Describes the design of a counter for β -rays using a tube made of a plastic scintillator as the detector. J.M.Hough

539.1.07 : 539.166

5972. MEASURING γ -RAY SPECTRA WITH LARGE PLASTIC SCINTILLATORS. G.L.Brownell, W.H.Ellet and H.D.LeVine. Nucleonics, Vol. 16, No. 12, 68, 70 (Dec., 1958).

Differential pulse height curves are given for γ -spectra from Na^{22} , Co^{60} , Cs^{137} , and I^{131} using a 16" diameter, 8" long plastic scintillator and a 16" diameter photomultiplier. R.D.Smith

539.1.07 : 539.16.08

SCINTILLATION COUNTING IN EXPERIMENTS ON PARITY CONSERVATION. See Abstr. 4989

539.1.07 : 535.376 : 539.17

INELASTIC NUCLEAR REACTIONS OF PROTONS IN SCINTILLATORS. See Abstr. 5038

539.1.07 : 537.533 : 621.383.27

PHOTOMULTIPLIERS FOR SCINTILLATION COUNTERS. See Abstr. 5798-9

539.1.07 : 537.591

5973. HIGHLY DIRECTIONAL DETECTOR FOR COSMIC RAY PARTICLES. G.W.Hutchinson.

Nuovo Cimento, Vol. 11, No. 3, 377-81 (Feb. 1, 1959).

A relatively simple Cherenkov detector is described which will respond to relativistic charged particles only when their directions lie within a well-defined cone. The limits of the cone are determined by the critical reflection of Cherenkov light from parallel faces of the radiator. The semi-angle of the cone may be chosen at will by varying the refractive indices used. It is suggested that the detector might be useful for attempts to detect a directional flux of uncharged primary particles at high altitudes.

539.1.07

5974. A WAVE-LENGTH SHIFTER FOR ČERENKOV RADIATION IN WATER AND AQUEOUS LEAD SALT SOLUTION.

K.Saito and K.Suga.

Nuovo Cimento, Vol. 11, No. 4, 600-5 (Feb. 16, 1959).

An increase factor of 4.4 in photomultiplier pulse-height was obtained by the use of pure amino G acid as a wavelength shifter for Cherenkov radiation in water. Further attempts were made to use this compound in a concentrated lead salt solution (1 M), and an increase factor of 1.8 was recorded, with the lead ion in the form of its ethylenediamine tetra-acetate (EDTA) complex.

539.1.07

5975. CONTINUOUS MEASUREMENT OF A NEUTRON FLUX BY THE ACTIVATION OF CIRCULATING SOLUTIONS.

L.Danguy and R.Quivy.

Internat. J. appl. Radiation and Isotopes, Vol. 5, No. 2, 135-40 (March, 1959). In French.

Sets out a method for continuously measuring a neutron flux by counting the activity induced in a solution circulating in a flexible loop, which allows the detector to assume any given shape. The choice of activated material in terms of the aim it must serve is discussed.

539.1.07

5976. SILVER PHOSPHATE GLASS DOSIMETER. I.Kügler. Atomkernenergie, Vol. 4, No. 3, 105-7 (March, 1959). In German.

For the detection of down to 2-3 r (150 keV X-rays). Annealing restores the irradiation effects.

539.1.07

5977. BUBBLE CHAMBER DETECTOR OF WEAK RADIO-ACTIVITY. G.Brautti, M.Ceschia and P.Bassi.

Nuovo Cimento, Vol. 10, No. 6, 1148-9 (Dec. 16, 1958).

The frequency of boiling of a 5 cm³ diethyl ether bubble chamber

was used as a measure of the intensity of ionizing radiation. The chamber is sensitive to recoil protons (from RaBe neutrons) between 120° and 133° C; for α -particles the sensitive range is from 90° to 100° C.

P.G.Murphy

539.1.07

5978. ON THE MASS MEASUREMENTS IN G-5 AND K-5 EMULSIONS.

L.Ciuffolotti, G.Luzzatto, G.Tomasini and G.Cortini.

Nuovo Cimento, Vol. 9, No. 6, 1110-13 (Sept. 16, 1958).

Careful measurements have been made of the gap densities and gap lengths as a function of range in proton and meson tracks in Ilford G5 and K5 emulsions, and estimates are made of a "fluctuation parameter" which measures the precision with which a single measurement may be expected to give the mass. This is especially small for K5 emulsion for a proton residual range of between 5 and 20 mm, when it is claimed, quite rapid measurements on a single 100μ cell can give the mass accurate to $\sim 15\%$.

S.J.Goldsack

539.1.07

5979. ON THE THINNING DOWN OF TRACKS OF HEAVY NUCLEI IN NUCLEAR EMULSIONS.

P.G.Bizzeti and M.Della Corte.

Nuovo Cimento, Vol. 11, No. 3, 317-33 (Feb. 1, 1959).

Photometric measurements of track widths were carried out in the thin-down region on C^{12} and O^{16} tracks and also on tracks of α and singly charged particles stopping in the emulsion. An appropriate model for the process of track formation in the thin-down region is proposed, and successfully tested on the experimental material.

539.1.07 : 537.591

PHOTOGRAPHY OF COSMIC RAYS IN A LUMINESCENT CHAMBER.

See Abstr. 5858

539.1.07

5980. AN AUTOMATIC SAMPLE CHANGER FOR WELL-TYPE SCINTILLATION COUNTERS.

D.V.Cohn, W.E.Carter and R.Anderson.

Internat. J. appl. Radiation and Isotopes, Vol. 4, No. 1-2, 118-21 (Dec., 1958).

A maximum of 25 samples may be assayed at one time by placing them in special carrier assemblies which are then inserted in a turntable mounted above the counter. A moving platform engages each carrier assembly in turn and positions it in the well. Although designed to operate directly with, and without modification of, specific commercially-available equipment, its principle of operation permits it to be readily modified for use with other counters, scalars or ratemeters.

539.1.07

5981. MAGNETIC SPECTROGRAPH FOR THE STUDY OF NUCLEAR REACTIONS.

M.Mazari, I.Castro, F.Alba and M.Vázquez R.

Rev. Mexicana Fis., Vol. 6, No. 1, 9-60 (Jan., 1957). In Spanish.

A broad-range magnetic spectrograph, similar to the one built by the High Voltage Laboratory Group of the Massachusetts Institute of Technology, was designed and built for the study of nuclear reactions of the light nuclei with the 2 MeV Van de Graaff machine of the National University of Mexico. Improvements to both equipments and their characteristics are described. As examples of the accuracy that can be obtained with the new instruments, the $O^{16}(d,p)O^{17}$ reaction was studied in order to determine whether the first excited state of O^{17} was a doublet or a singlet. The oxygen reaction and elastic scattering on C^{12} and Au^{197} were used to calibrate the radius of curvature of the deflecting magnet. Due to the cross-section studies that the laboratory is carrying out using fast neutrons and for the general interest of knowing the accurate Q value of the reaction $T(d,\alpha)n$, exposures at 90° , 80° and 60° with respect to the direction of a beam hitting a tritium target were made, bombarding it with 0.63 MeV deuterons. The mean Q value obtained including relativistic corrections is 17.580 ± 0.025 MeV. The outstanding characteristics of this spectrograph are the high resolution energy range (2.74) covered simultaneously in an exposure and the possibility of rotating the spectrograph from 0° to 130° with respect to the beam direction.

539.1.07

5982. A PAIR SPECTROMETER FOR THE MEASUREMENT OF A 30 MeV BREMSSTRAHLUNG SPECTRUM.

B.Ziegler.

Z. angew. Phys., Vol. 10, No. 9, 397-403 (Sept., 1958). In German.

The basic design of this spectrometer was that suggested by Walker (Abstr. 3896/1948). Various design points were examined,

such as: the optimum width of the pair producing foil; the angular distribution of the electron pairs and the arrangement of the coincidence counters. The foil was 10μ platinum which was mounted in a magnetic field of 8 kG. Scintillation counters were used as detectors. The spectrometer constructed had a resolving power of 2% and was used to measure the bremsstrahlung spectrum from a thick target in a betatron. The results obtained agreed with Schiff's theory.

D.H.Lord

539.1.07 : 535.33.07 : 537.531

CURVED CRYSTAL GAMMA-RAY SPECTROMETER.

See Abstr. 5773

539.1.07

5983. MAGNETIC TAPE SIMPLIFIES HANDLING OF NUCLEAR DATA.

D.W.Halfhill.

Nucleonics, Vol. 16, No. 12, 55-7, 66 (Dec., 1958).

A review of the methods of using tape for data recording and analysis. Methods of recording include direct intensity recording, frequency modulation, pulse duration modulation and digital recording. Other uses include multichannel data recording, including coincidence studies, recording of data during emergency conditions e.g. accidental reactor shutdowns, and high speed recording.

R.D.Smith

ELEMENTARY PARTICLES

539.12

5984. MEASUREMENT OF POLARIZATION QUANTITIES.

A.G.Zimin.

Zh. eksper. teor. Fiz., Vol. 33, No. 5 (11), 1300 (1957). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 6(33), No. 5, 1000 (May, 1958).

Formulae for the reduction in the scattering asymmetry originating from the finite aperture of the counters are given. (See also Abstr. 684/1958).

J.Lascoux

539.12

5985. RAYLEIGH SCATTERING OF POLARIZED PHOTONS.

D.Brini, E.Fuschini, D.S.R.Murty and P.Veronesi.

Nuovo Cimento, Vol. 11, No. 4, 533-45 (Feb. 16, 1959).

Two criteria are discussed for comparing in a decisive manner the theoretical predictions on the Rayleigh scattering deduced by Franz and by Brown and Mayers. The first deals with the study of the Rayleigh scattering of the polarized photons, the second considers the polarization effects due to the Rayleigh scattering of an unpolarized radiation. In the elastic scattering of polarized photons an asymmetry ratio R can be defined as

$$(\frac{d\sigma_0}{d\Omega} + \xi_{\parallel} \frac{d\sigma_1}{d\Omega}) / (\frac{d\sigma_0}{d\Omega} + \xi_{\perp} \frac{d\sigma_1}{d\Omega}),$$

where the numerator and the denominator represent the Rayleigh cross-section for the same angle of scattering in two orthogonal planes. The quantities $\xi_{\parallel}$ and $\xi_{\perp}$ are the degrees of polarization of the incident beam referred to the previous planes, while $d\sigma_0/d\Omega$ is the cross-section for the unpolarized photons and $d\sigma_1/d\Omega$ is the term sensitive to polarization. The value of R was determined by using a beam of photons of energy 1.28 mc^2 scattered on a target of Hg at angles of scattering $\theta_1 = 65^{\circ}$, $\theta_2 = 90^{\circ}$ and $\theta_3 = 110^{\circ}$. The experimental results are in closer agreement with the calculations of Brown and Mayers. The polarized beam was obtained by means of a Compton scattering at an angle of 50° of the unpolarized beam coming from a Co^{60} source.

539.12

5986. A STUDY OF THE BACK-SCATTERING OF γ -RADIATION.

N.Dubinskaya and U.Ulmanis.

Latv. PSR Zinat. Akad. Vestis, 1957, No. 7(120), 147-50. In Russian.

An experimental study using different scatterers and γ -ray energies up to 1250 keV; results presented graphically.

W.O.Lock

539.12

5987. CONTRIBUTION OF ANNIHILATION RADIATION TO THE GAMMA-RAY FLUX IN LEAD.

M.J.Berger, J.H.Hubbell and I.H.Reingold.

Phys. Rev., Vol. 113, No. 3, 857-62 (Feb. 1, 1959).

Multiply-scattered gamma-rays from a high-energy source, upon being absorbed, give rise to a secondary flux of annihilation radiation.

A procedure is developed, within the framework of the moment method of Spencer and Fano, (Abstr. 7929/1951), for calculating the production and diffusion of the annihilation radiation. The treatment includes infinite as well as semi-infinite media. Numerical results are presented for primary radiation sources with energies between 2 and 10 MeV in a lead medium. These results can be represented by simple semiempirical formulae.

539.12

5988. POLARIZATION NEAR THE HIGH-FREQUENCY LIMIT OF 500 keV BREMSSTRAHLUNG. J.W.Motz and R.C.Placious. Phys. Rev., Vol. 112, No. 4, 1039-40 (Nov. 15, 1958).

The angular dependence of the linear polarization near the high-frequency limit of the bremsstrahlung spectrum for 500 keV electrons was measured with a polarimeter that depends on the polarization sensitivity of the Compton process. The results confirm the polarization reversal predicted at large angles by the Gluckstern-Hull-Breit calculations, (Abstr. 6073/1953) and are consistent with the reversal found in the photoelectric measurements of McMaster and Hereford (Abstr. 9609/1956).

539.12

5989. MEASUREMENT OF THE CIRCULAR POLARIZATION OF THE BREMSSTRAHLUNG PRODUCED BY ELECTRONS FROM ^{204}Tl . U.Amaldi, Jr, M.Bernardini, P.Brovetto and S.Ferroni. Nuovo Cimento, Vol. 11, No. 3, 415-23 (Feb. 1, 1959).

The polarization of the external bremsstrahlung produced by the electrons emitted by Ti^{204} near the top of the spectrum (first order unique forbidden transition) was measured by means of the technique of the forward Compton scattering on magnetized iron. The observed effect agrees, within experimental error (about 10%), with the value expected for $-v/c$ polarized electrons.

539.12 : 539.165

5990. INVERSE BETA DECAY AND THE TWO-COMPONENT NEUTRINO. R.W.King and J.F.Perkins. Phys. Rev., Vol. 112, No. 3, 963-6 (Nov. 1, 1958).

Several procedures for calculating the average cross-section per antineutrino from U^{235} fission are given to test the predictions of the two-component neutrino theory. A firm lower limit of $\bar{\sigma}_p > 7 \times 10^{-44} \text{ cm}^2$ is deduced from the known decays of the fission products. Three different procedures, if weighted equally, give a "best value" of $\bar{\sigma}_p = 14 \times 10^{-44} \text{ cm}^2$ to be compared with the recently increased experimental value $\bar{\sigma}_p = 11 \pm 4 \times 10^{-44} \text{ cm}^2$. It is concluded that predictions of the two-component neutrino theory are in accord with the experimental results on inverse beta decay.

539.12

5991. ON THE PROBLEM OF THE ENERGY SPECTRUM OF AN ELECTRON ON OPEN PERIODICAL TRAJECTORIES. G.E.Zil'berman.

Zh. eksper. teor. Fiz., Vol. 34, No. 2, 515-16 (1958). In Russian. English summary: PB 141052T-1, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

An equation is stated for the quasiclassical approximation. The solution is technically by far more complicated than is the case with Schroedinger's equation since it is not a differential but a difference equation. The solutions, however, have the same general properties. The expressions for the first 4 approximations are put down explicitly and are discussed in detail. The course of calculation is detailed. The average of the tolerable discontinuities is found by means of the same relation as are the discreet discontinuities with closed trajectories. The width of the discontinuities (razryv) can be determined by means of an ordinary dispersion equation. This equation is stated and is always solvable.

539.12

5992. PROPOSED METHOD FOR DIRECT MEASUREMENT OF THE g-FACTOR OF FREE ELECTRONS. P.S.Farago. Proc. Phys. Soc., Vol. 72, Pt 5, 891-4 (Nov., 1958).

A possible method of measuring the g-factor of electrons to an accuracy of about $1 : 10^5$, by comparing the spin precession frequency and angular velocity of orbital motion of polarized electrons emitted by a β -active source in crossed homogeneous electric and magnetic fields, is discussed.

C.J.Batty

539.12

5993. ELECTRON SCATTERING CROSS SECTION WITH RELATIVISTIC CORRECTION BASED ON THE THOMAS-FERMI THEORY. T.Tietz.

Phys. Rev., Vol. 113, No. 4, 1056-7 (Feb. 15, 1959).

A formula for the total cross-section for elastic scattering of

fast electrons by a Thomas-Fermi potential, including relativistic effects, is derived from the differential cross-section previously obtained (Abstr. 5187/1958).

539.12

5994. PRECISION MEASUREMENT OF THE ENERGY LOSS OF ELECTRONS PASSING THROUGH THIN FOIL. S.Arai. Sci. Rep. Tohoku Univ. First Ser., Vol. 41, No. 4, 195-208 (Jan., 1958).

The energy loss of 20 keV electrons passing through Al foil 420 Å thick, placed at an inclination 45° to the primary electron beam, was measured. The apparatus permitted the energy loss of a sharp spectral line to be measured within $\pm 0.02 \text{ eV}$ or less.

539.12

5995. ENERGY LOSSES OF ELECTRONS PASSING THROUGH FOILS OF ALUMINIUM AND OF ALUMINIUM OXIDE. S.Arai. Sci. Rep. Tohoku Univ. First Ser., Vol. 41, No. 4, 209-20 (Jan., 1958).

Using the apparatus previously described (see preceding abstract) measurements were made with varying foil thickness, incident angle of electron beam to the foil, primary energy of electron and current density of the beam. The energy losses were found to be dependent upon all these factors to a slight but definite extent, except upon the current density. Energy losses in Al foil treated under various conditions, and those in Al_2O_3 foil, were also measured.

539.12

5996. ON THE THEORY OF THE ABSORPTION OF MONO-ENERGETIC ELECTRONS IN METAL FOILS. H.Meister. Z. Naturforsch., Vol. 13a, No. 10, 809-20 (Oct., 1958). In German.

The absorption of electrons in a homogeneously activated layer and in adjacent foils is calculated. Electrons are considered to undergo deceleration without change of direction up to a range given by transport theory, then suddenly to assume a state of complete diffusion. The approximation limits the validity of the theory to absorbers of atomic number greater than 30; for two such (In and Au) there is experimental confirmation.

A.E.I. Research Laboratory

539.12

5997. THE EFFECTIVE CROSS-SECTION FOR PAIR PRODUCTION BY 6.3 MeV GAMMA QUANTA IN THE COULOMB FIELD OF THE ELECTRON. C.J.Frei, H.H.Staub and H.Winkler. Helv. phys. Acta, Vol. 31, No. 5, 491-510 (1958). In German.

The production cross-section was determined by measuring the ratio of the total, nuclear and electronic pair cross-sections for the pairs of elements Be-Al and Mg-C. Representing the pair formation cross-section per atom by

$$\Phi = r_0^2 \alpha [\Gamma_n(E) \cdot Z^2 + \Gamma_e(E) Z],$$

it is found that the ratio of electronic to nuclear cross-section Γ_e/Γ_n at $E = 6.3 \text{ MeV}$ is equal to 0.5 ± 0.05 , which is very close to the theoretical value 0.4 given by Borsellino.

539.12

5998. INTERNAL PAIRS IN THE CAPTURE OF π^- BY PROTONS. R.M.Rockmore and J.G.Taylor.

Phys. Rev., Vol. 112, No. 3, 992-4 (Nov. 1, 1958).

The contribution from nucleon structure to the process $\pi^- + p \rightarrow n + e + e^+$ is calculated. The dispersion relations for photoproduction of π -mesons by virtual photons together with crossing symmetry are used. The nucleon structure contribution is found to be of the order of 2% and of the same size as the contribution from longitudinal polarization. The effect cannot be detected from present data. A 25% discrepancy between theory and experiment, which results from using the more reliable Panofsky ratio 1.8, still persists.

539.12 : 530.145

WAVE EQUATION FOR A FREE NUCLEON. See Abstr. 5379

539.12

5999. NEUTRAL VECTOR MESON AND NUCLEON FORM FACTORS AND MAGNETIC MOMENTS. R.W.Huff. Phys. Rev., Vol. 112, No. 3, 1021-6 (Nov. 1, 1958).

The existence of the heavy neutral vector meson recently suggested by Nambu (Abstr. 9010/1957) is studied as a possible explanation of two phenomena: (1) the small charge root-mean-square radius of the neutron, and (2) the nucleon anomalous magnetic moments. The types and strengths of its interactions required to account for these phenomena are then used to predict the modes and rates of its decay as a function of its mass. The possibility of its detection by observation of these decay products is briefly discussed. Results are inconclusive.

- 539.12
6000. HYPERFINE STRUCTURE AND STRUCTURE OF THE NUCLEON. E.Werner.
Naturforsch., Vol. 13a, No. 3, 238-9 (March, 1958). In German.
 The hyperfine structure of the ground state of deuterium is recalculated assuming a finite size of the nucleons and for various potential models. Results are compared with experimental values.
 G.Martelli
- 539.12
6001. ON THE MAGNITUDE OF STRANGE PARTICLE PRODUCTION CROSS-SECTION IN NUCLEON-NUCLEON COLLISIONS AT COSMOTRON ENERGY. V.S.Barashenkov and V.M.Maltsev.
Acta phys. Polon., Vol. 17, No. 6, 397-400 (1958).
 The probabilities of production of different kinds of particles and their momentum distribution for N-N collisions at $E = 3$ BeV are calculated. The results of the calculation are compared with the experiment.
- 539.12
6002. NUCLEON FORM FACTORS FROM ELECTROPRODUCTION OF PIONS. S Gartenhaus and C.N.Lindner.
Phys. Rev., Vol. 113, No. 3, 917-20 (Feb. 1, 1959).
 The dispersion relation analysis of Fubini, Nambu and Wataghin (Abstr. 6174/1958) for electroproduction of pions was applied to the experiments of Panofsky and Allton (Abstr. 5231/1958) as an independent means for studying nucleon structure. The results are in qualitative agreement with those from elastic scattering experiments. Some of the limitations inherent in the form-factor measurements by this process are also discussed.
- 539.12 : 539.14
6003. THE ANGULAR DISTRIBUTION OF PROTONS IN THE DIRECT PHOTONUCLEAR EFFECT. J.Eichler and H.A.Weidenmüller.
Z. Phys., Vol. 152, No. 3, 261-71 (1958). In German.
 The angular distribution of protons emitted in the E1 absorption, with momentum l , according to a shell model, is a superposition of the transitions $l \rightarrow l+1$ and $l \rightarrow l-1$. Whilst for the pure transition $l \rightarrow l+1$ or $l \rightarrow l-1$, the angular distribution depends only on l , for a superposition of the two transitions it depends also on the dipole absorption. In particular, the effect of interference between the two transitions on the angular distribution is not negligible. The distribution is calculated numerically for protons in p, d and f states, assuming a square well potential; the dependence on the parameters of the potential is also discussed. The contribution from quadrupole terms is evaluated. The results show a better agreement with the existing experimental data, and a qualitative interpretation of the effects observed by Osokina and Ratner (Abstr. 5629/1957) is made possible.
 G.Martelli
- 539.12 : 539.17
6004. EXPERIMENTAL RANGE OF PROTONS IN Al. H.Bichsel.
Phys. Rev., Vol. 112, No. 4, 1089-91 (Nov. 15, 1958).
 The ranges of protons of 1 to 6 MeV were determined experimentally. Combining these results with earlier experimental data, the range can be represented by the following analytic functions: for $1 < E < 2.7$ MeV, $R = 3.837 E^{1.5874}$; for $2.7 < E < 20$ MeV, $R = 2.837 E^2 / (0.68 + \log_{10} E)$, with E in MeV and R in mg/cm^2 . A tentative comparison with the theory of stopping power was made. The neutron thresholds for proton bombardment of C^{13} , F^{19} and Na^{23} were obtained as an incidental result.
- 539.12
6005. ANTIPROTON-PROTON CROSS SECTIONS AT 133, 197, 265, AND 333 MeV. C.A.Coombes, B.Cork, W.Galbraith, G.R.Lambertson and W.A.Wenzel.
Phys. Rev., Vol. 112, No. 4, 1303-10 (Nov. 15, 1958).
 Antiprotons, produced internally in a bevatron, channelled externally by a system of magnetic quadrupoles and bending magnets, and identified by time of flight, entered a target containing liquid hydrogen. This target was completely surrounded by a system of scintillation counters which detected both scattered antiprotons and annihilation secondaries. An electrostatic-magnetic velocity spectrometer was used in the external magnetic channel to increase the ratio of antiprotons to pions. The $\bar{p}$ -p total, elastic, inelastic, and charge-exchange cross-sections, and the angular distribution of elastic scattering were measured at each energy. The inelastic cross-section is approximately one-half the total cross-section at these energies. The results are discussed in connection with current theories.
- 539.12
6006. SLOW-NEUTRON SCATTERING BY ROTATORS. H.C.Volkin.
Phys. Rev., Vol. 113, No. 3, 866-74 (Feb. 1, 1959).
 The methods of Zemach and Glauber (Abstr. 3301/1956) for treating the scattering of low-energy neutrons by molecules are extended for the rotational degrees of freedom to any type of rotator. A procedure is developed which enables their results to be generalized to symmetric or asymmetric molecules. The method is then applied to the calculation of the direct scattering up to the accuracy of the first quantum-mechanical correction to the classical cross-section.
- 539.12
6007. THE COOLING EFFECT OF [THERMAL NEUTRON] DIFFUSION. K.H.Beckurts.
Z. Naturforsch., Vol. 12a, No. 12, 956-9 (1957). In German.
 Starting from a simplified model of a finite scattering medium, the author calculates the equilibrium spectrum of thermal neutrons in such a medium. It is found that diffusion effects may bring about a considerable modification of the Maxwellian velocity distribution. The calculation is compared with a simplified theory, according to which the diffusion effect is described by a decrease of neutron temperature.
 F.Lachman
- 539.12
6008. DETERMINATION OF THE DIFFUSION PARAMETER OF THERMAL NEUTRONS IN WATER BY A "POISONING" METHOD. K.H.Beckurts and O.Klüber.
Z. Naturforsch., Vol. 13a, No. 10, 822-5 (Oct., 1958). In German.
 This parameter was measured by determining the radial neutron flux from a Ra-Be source inside a Cd sphere when placed inside a cylinder containing either water or various borax solutions. A correction was applied to these measurements to allow for the "hardening" of the neutron spectrum by the strongly absorbing boron. Using a value (obtained by the Dardel and Sjöstrand difference method) of 747 barns for the boron atomic absorption cross-section, the diffusion parameter was found to be $(3.53 \pm 0.11) \times 10^4 \text{ cm}^2/\text{sec}$ for light water at 20°C .
 D.H.Lord
- 539.12
6009. ON THE FLUCTUATION OF THE SLOWING DOWN TIME OF NEUTRONS. L.Pál and G.Németh.
Nukleonik, Vol. 1, No. 5, 165-7 (April, 1959).
 The mean slowing down time of neutrons $t_1(u)$ and its standard deviation $D(u)$ are determined. For the relative standard deviation, a relation is obtained, which is a good approximation in the case of high lethargy values.
- 539.12
6010. RESONANCE CAPTURE OF NEUTRONS IN INFINITE HOMOGENEOUS MEDIA. R.Schermer and N.Corngold.
Proc. Phys. Soc., Vol. 73, Pt 4, 561-71 (April, 1959).
 In a previous paper (Abstr. 688/1958), a variational principle was introduced for 1-p, the capture probability for neutrons slowing down in a homogeneous medium of infinite extent. In the present paper, the variational principle is used together with simple but accurate trial functions to obtain expressions for (i) corrections to the commonly used "narrow resonance" formula for capture and (ii) interference effects in the capture of neutrons by closely spaced resonances.
- 539.12
6011. SPACE-ENERGY DISTRIBUTION OF NEUTRONS IN A HEAVY GASEOUS MODERATOR. M.V.Kazarnovskii.
Zh. eksper. teor. Fiz., Vol. 33, No. 6 (12), 1533-5 (1957). In Russian. English translation in: *Soviet Physics — JETP* (New York), Vol. 6 (33), No. 6, 1186-7 (June, 1958).
 The equation for the space-energy distribution function in a heavy monatomic gas, with constant mean free path and finite dimensions, is solved exactly for the case of weak absorption. The solution is obtained as an expansion of orthonormal Laplace functions. The normalizing constants are obtained by comparing the asymptotic form with the Fermi age approximation.
 D.H.Lord
- 539.12
6012. THE GREATEST POSSIBLE OUTPUT OF A Ra + Be-NEUTRON SOURCE. F.Berthold and P.Jensen.
Z. Naturforsch., Vol. 13a, No. 2, 143-7 (Feb., 1958). In German.
 A $\text{Ra} + \text{Be}$ source was constructed by mounting a beryllium disk opposite a thin film of Ra , frozen on a glass surface. Range measurements were made on the α -rays from the Ra , using an absorption column of air and a proportional counter. The source was placed

inside a paraffin moderator and the activity induced (by thermal neutrons) in Dy_2O_3 samples was measured. This showed that the α -rays were not retarded in their source and that hardly any recoil nuclei left the Rn. These measurements gave the optimum output of a Ra + Be source as 16 800 neutrons per sec per mC of Ra and its decay products (except polonium). D.H.Lord

539.12

6013. ASYMMETRY PARAMETER IN MUON DECAY. M.Bardon, D.Berley and L.M.Lederman.

Phys. Rev. Letters, Vol. 2, No. 2, 56-7 (Jan. 15, 1959).

A beam of μ^+ -mesons of well-defined transverse polarization was obtained from the decay in flight of π^+ -mesons near the cut-off angle. A μ^+ -meson, stopping in a bromoform target, triggered a pulsed magnetic field of 1 μ sec duration, used to cause precession of the direction of polarization of the μ -mesons through $\pm 90^\circ$, so that the spins pointed towards one or other of a pair of opposed counter telescopes. Allowing, on the basis of the two component theory of the neutrino, for the energy spread of the electrons counted by the telescopes, the asymmetry parameter has been calculated to be $a \geq 0.325 \pm 0.015$. From this it follows that, in terms of the coupling constants for the scalar and vector parts of the coupling $|g_S|^2/|g_V|^2 \leq 0.05 \pm 0.09$. S.J.Goldsack

539.12

6014. RADIATIVE DECAY OF THE MUON.

T.Kinoshita and A.Sirlin.

Phys. Rev. Letters, Vol. 2, No. 4, 177-8 (Feb. 15, 1959).

The photon spectrum in radiative muon decay is derived, in two-component neutrino theory. It appears that the inner bremsstrahlung accompanying this process may be observable with present techniques. R.J.N.Phillips

539.12

6015. ABOUT THE μ -MESON SPIN FROM IONIZATION BURSTS DATA. I.X.Ion, N.J.Ionescu-Pallas and C.C.Potoceanu.

Nuovo Cimento, Vol. 11, No. 4, 507-24 (Feb. 16, 1959).

Accurate calculations of appearance frequencies of bursts generated by muons in a shielding layer of lead at sea level were performed. Cross-sections for bremsstrahlung when the screening of the nucleus by the orbital electrons is incomplete, and Furry's distribution model, revised by Christy and Kusaka in order to diminish the fluctuations, was used. Theoretical results are in good agreement with experimental data in the range 100-1200 particles, assuming a spin $\frac{1}{2}$ for the μ -meson.

539.12

6016. HELICITY OF NEGATIVE MUONS FROM PION DECAY.

W.A.Love, S.Marder, I.Nadelhaft, R.T.Siegel and A.E.Taylor.

Phys. Rev. Letters, Vol. 2, No. 3, 107-10 (Feb. 1, 1959).

The negative muons were stopped in a pentane target and a measurement made of the asymmetry in the β -decay of B^{12} produced by the reaction $\mu^- + \text{C}^{12} \rightarrow \text{B}^{12} + \nu$. Forward and backward counter telescopes were used to observe the decay electrons. The asymmetry was measured by counting with a longitudinal magnetic field to preserve the polarization of B^{12} and with a transverse magnetic field to destroy this polarization. The observed decay time of 20.4 ± 1.1 msec was consistent with that of B^{12} . The observed forward and backward asymmetries were $-(2.36 \pm 1.58)\%$ and $+(2.88 \pm 1.30)\%$. These results combined give for the coefficient of $\cos \theta$ $a = +(2.68 \pm 1.00)\%$. The + sign indicates + helicity for the negative muons in agreement with the two component theory plus conservation of leptons. A similar measurement from activities due to stopped pions gave $a_\pi = -(1.10 \pm 1.26)\%$. A.Ashmore

539.12

6017. MUON K-CAPTURE COMPARED TO β -DECAY FOR $\text{C}^{12} \leftrightarrow \text{B}^{12}$.

J.O.Burgman, J.Fischer, B.Leontic, A.Lundby, R.Meunier, J.P.Stroot and J.D.Teja.

Phys. Rev. Letters, Vol. 1, No. 12, 469-71 (Dec. 15, 1958).

A mixed π^- , μ^- and e^- beam of 220 MeV/c momentum was stopped in a scintillation crystal $10 \text{ cm} \times 10 \text{ cm} \times 6 \text{ cm}$ thick, and the decay electrons from μ^- and from B^{12} were detected in the same crystal. The rate for K-capture of μ^- mesons was measured by detecting the 20.6 msec activity of B^{12} . The ratio of the rates of μ -meson capture giving B^{12} to the rate of decay of B^{12} to the ground state of C^{12} was measured as 312 ± 18 . A theoretical value based on recent refinements of the V-A Universal Fermi interaction is 228. S.J.Goldsack

6018. SECONDARY ELECTRONS AND PHOTONS OF μ -MESONS IN SOLIDS. K.Ott and H.Preuss.

Z. Naturforsch., Vol. 12a, No. 6, 451-65 (1957). In German.

Electrons and photons associated with integral energy spectra of the μ -meson component at sea level have been calculated for several solids (C, Fe and Pb layers of 0-50 g/cm²) at energies between 0 and 100 MeV. Results are presented in the form of graphs F.Lachman

539.12

6019. SCATTERING OF POLARIZED μ MESONS FROM EXTENDED NUCLEI. G.H.Rawitscher.

Phys. Rev., Vol. 112, No. 4, 1274-81 (Nov. 15, 1958).

Scattering solutions of the Dirac equation for a muon in the static electric field of an extended nucleus are numerically obtained for various values of the velocity of the incident particle ($\beta = 0.4$ to 0.8) and of the charge of the scattering nucleus ($Z = 48$ and 80). A Stanford Fermi-type shape for the extended nuclear charge distribution is assumed. Angular distributions of the unpolarized cross-section and of the left-right scattering asymmetries (S) of a transversely polarized beam of μ^+ and μ^- mesons are presented. For μ^- the finite nuclear size strongly reduces S in the forward directions. The reduction of the cross-section seems to be more sensitive to the detailed shape of the charge distribution than is the reduction of S. In the case of μ^+ , S is appreciably altered from the "point" value, and can depend sensitively on the shape of the nuclear charge distribution. The value of S can be larger for the extended nucleus than for the point nucleus.

539.12

6020. ELECTRON DECAY OF THE POSITIVE PION.

H.L.Anderson, T.Fujii, R.H.Miller and L.Tau.

Phys. Rev. Letters, Vol. 2, No. 2, 53-6; Addendum, 64 (Jan. 15, 1959).

A system of scintillation counters incorporating a double focusing β -ray spectrograph was used to detect the direct β -decay of the π^+ -meson. The measured branching ratio was $(1.03 \pm 0.20) \times 10^{-4}$, in good agreement with the other recent measurements, and with the predictions of the A-V theory. To check that events counted were indeed those due to β -decay of the π^+ , the π^+ lifetime was measured using the $\pi^+ \rightarrow e^+$ events only, and the end point of the electron energy spectrum was compared with that for the μ -meson decays. Both measurements agreed well with the expected values. S.J.Goldsack

539.12

6021. ON THE SECOND NEUTRAL PION. W.Królikowski.

Nuclear Phys., Vol. 10, No. 3, 213-14 (March, 1959). Also in: Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys., Vol. 7, No. 2, 97-8 (1959).

The charge parity of the hypothetical second neutral pion is discussed and a possibility of absence of strong interactions for this particle is pointed out.

539.12 : 530.145

RADIATIVE CORRECTIONS IN THE DISPERSION RELATIONS FOR $\pi^\pm + p \rightarrow \pi^\pm + p$. See Abstr. 5377

539.12

6022. PROPOSAL FOR DETERMINING THE PION-NUCLEON COUPLING CONSTANT FROM THE ANGULAR DISTRIBUTION FOR NUCLEON-NUCLEON SCATTERING. G.F.Chew.

Phys. Rev., Vol. 112, No. 4, 1380-3 (Nov. 15, 1958).

A plausibility argument is made that the real and imaginary parts of the nucleon-nucleon scattering amplitude as a function of the cosine of the barycentric system scattering angle, for fixed energy, are analytic in the complex plane, with singularities confined to the real axis. It is conjectured that in the real part there are poles at

$$\cos \theta = \pm(1 + \mu^2/2k^2),$$

where μ is the pion rest mass and k the barycentric momentum, and branch points at

$$\cos \theta = \pm(1 + 2\mu^2/k^2), \pm(1 + 9\mu^2/2k^2), \text{ etc.}$$

The residues of the poles are related directly to g^2 , the pion-nucleon coupling constant, and a procedure is outlined for determining g^2 by an extrapolation of experimental data on either backward or forward nucleon-nucleon scattering.

539.12
6023. THE PRODUCTION OF CASCADE PARTICLES BY 5.5 GeV/c PIONS. W.B.Fowler, W.M.Powell and J.I.Shonle. *Nuovo Cimento*, Vol. 11, No. 3, 428-37 (Feb. 1, 1959).
The first observed production of negative cascade particles at an accelerator is reported. A 30 in. propane bubble chamber was exposed to a beam of negative pions of 5.5 GeV/c. Two cascades were identified, indicating a production cross-section of $2.3^{+3.1}_{-1.6} \mu\text{b}$. The Q values found were $(49.5 \pm 7.9) \text{ MeV}$ and $(53.6 \pm 11.3) \text{ MeV}$. The lifetimes were $(1.9 \pm 0.1) \times 10^{-10} \text{ sec}$ and $(5.2 \pm 0.4) \times 10^{-10} \text{ sec}$. Both Ξ 's were produced backwards in the centre-of-momentum system. The identification process and background is discussed.

539.12
6024. PION-HYPERON SCATTERING AND K^-p REACTIONS. M.Ross. *Phys. Rev.*, Vol. 112, No. 3, 986-91 (Nov. 1, 1958).

A brief survey is made of the consequences of the universal pion-baryon interaction on production of hyperons with pions. In particular, a pion-hyperon resonant scattering state similar to the $P_{3/2}$, $T = \frac{3}{2}$ pion-nucleon state should exist. Possible effects of this state are examined. It is found that the large low-energy K^-p cross-sections cannot be associated with it. Other experiments are suggested in order to search for this state, especially K^-p reactions at higher energy and pion production in hyperon-nucleon scattering.

539.12
6025. SCATTERING OF 31.5 MeV POSITIVE PIONS FROM CARBON. P.P.Kane. *Phys. Rev.*, Vol. 112, No. 4, 1337-43 (Nov. 15, 1958).

Measurements were made at laboratory angles from 40° to 145° . Pulse-height analysis was used to select elastic scattering events. The observed differential cross-sections for elastic scattering indicate destructive interference between the Coulomb and nuclear scattering amplitudes. The presence of inelastic pion scattering is inferred from a combination of different methods of study: pulse-height analyses, absorption measurements, and detailed comparisons of the data obtained in the case of carbon with those obtained in the case of copper and lead. An upper limit of 2 is placed on the spin of the 9.6 MeV state of C^{12} . This is not in disagreement with the results of other experiments and existing theoretical predictions.

539.12
6026. ALTERNATIVE METHOD FOR COMPARING PION-PROTON SCATTERING DATA WITH DISPERSION EQUATIONS. H.J.Schnitzer and G.Salzman. *Phys. Rev.*, Vol. 113, No. 4, 1153-5 (Feb. 15, 1959).

A method for comparing pion-proton scattering experiments with the predictions of the forward angle scattering dispersion equations is proposed, which allows the usual statistical measure (χ^2) of the agreement. A slight discrepancy is found between negative pion-proton data and the theory; however, the overall agreement is considered satisfactory. Values of the coupling constant and S-wave zero-energy scattering lengths are determined. They are $f^2 = 0.08 \pm 0.01$, $a_1 = 0.193 \pm 0.050$, and $a_3 = -0.089 \pm 0.048$.

539.12
6027. PION-PROTON RESONANCE SCATTERING NEAR 900 MeV. H.C.Burrowes, D.O.Caldwell, D.H.Frisch, D.A.Hill, D.M.Ritson, R.A.Schluter and M.A.Wahlig. *Phys. Rev. Letters*, Vol. 2, No. 3, 119-21 (Feb. 1, 1959).

The scattering of negative and positive pions by hydrogen in the energy range of 470 to 1200 MeV is investigated in order to clarify the broad resonance occurring near 900 MeV. For π^- scattering the results show two clearly separated peaks at total centre of mass energies of 615 ± 40 and $775 \pm 40 \text{ MeV}$. No peaks are noted in the π^+ scattering in this region. S.J.St-Lorant

539.12
6028. SCATTERING OF 333 MeV NEGATIVE π -MESONS BY HYDROGEN. V.G.Zinov and S.M.Korenchenko. *Zh. eksper. teor. Fiz.*, Vol. 33, No. 5(11), 1307-8 (1957). In Russian. English translation in: *Soviet Physics — JETP* (New York), Vol. 6(33), No. 5, 1006-7 (May, 1958).

Differential cross-sections for elastic scattering (I) and for charge-exchange scattering (II) were measured using scintillation counters. The total cross-section for (I) is $10.7 \pm 0.6 \text{ mbn}$, and for (II) is $16.6 \pm 1.4 \text{ mbn}$, giving a total cross-section for all interactions, after including meson production, of $28.8 \pm 1.8 \text{ mbn}$.

C.J.Batty

539.12
6029. SCATTERING OF 307 MeV NEGATIVE π -MESONS BY HYDROGEN WITH CHARGE EXCHANGE. V.G.Zinov and S.M.Korenchenko. *Zh. eksper. teor. Fiz.*, Vol. 33, No. 5(11), 1308-9 (1957). In Russian. English translation in: *Soviet Physics — JETP* (New York), Vol. 6(33), No. 5, 1007-8 (May, 1958).

From measurements of angular distribution using scintillation counters, the total cross-section was found to be $18.4 \pm 1.6 \text{ mbn}$.

C.J.Batty

539.12
6030. THE CAPTURE OF NEGATIVE PIONS IN HYDROGEN AND DEUTERIUM. I. HYDROGEN. J.A.Kuehner, A.W.Merrison and S.Tornabene. *Proc. Phys. Soc.*, Vol. 73, Pt 4, 545-50 (April, 1959).

A high-energy pair spectrometer was used to determine the ratio of the radiative to mesonic capture of pions stopped in liquid hydrogen. This measurement agrees well with the value expected from the charge-exchange scattering and photoproduction of pions.

539.12
6031. THE CAPTURE OF NEGATIVE PIONS IN HYDROGEN AND DEUTERIUM. II. DEUTERIUM. J.A.Kuehner, A.W.Merrison and S.Tornabene. *Proc. Phys. Soc.*, Vol. 73, Pt 4, 551-5 (April, 1959).

The apparatus described was used to study the radiative capture of pions in liquid deuterium. The result agrees well with previous measurements and the value expected from the production of pions in nucleon-nucleon collisions.

539.12 : 539.17
6032. SECOND RESONANCE IN PION PHOTOPRODUCTION. M.J.Moravcsik. *Phys. Rev. Letters*, Vol. 2, No. 4, 171-2 (Feb. 15, 1959).

It is suggested that measurement of the angular distribution of pions, produced by photons polarized perpendicular to the production plane can be used as a test of the hypothesis that the second resonance is in a $D_{3/2}$, E1 state. Assuming that only the S-wave and the resonance contribute appreciably to the cross-section, the distribution will be isotropic if and only if the resonance is of this form. The method has the advantage that the meson current term does not contribute to the cross-section. E.J.Squires

539.12
6033. PHOTOPRODUCTION OF CHARGED PIONS FROM DEUTERIUM. R.H.Land. *Phys. Rev.*, Vol. 113, No. 4, 1141-6 (Feb. 15, 1959).

This was studied using a "monochromatic" gamma-ray beam of $292 \pm 8 \text{ MeV}$. The energy spectra of both positive and negative pions at the laboratory angle of 120° were determined and both agreed within experimental error with that predicted by the theory of Lax and Feshbach. The negative-to-positive ratio at 120° was 1.07 ± 0.16 , and within experimental error, was independent of meson energy. At an angle of 73° the ratio was 0.90 ± 0.23 for 98.7 MeV mesons. The measured negative-to-positive ratio disagrees both with the simple classical picture of Brueckner and the phenomenological theory of Watson. Some results on the ratio using a bremsstrahlung beam are given.

539.12
6034. MULTIPLE MESON PRODUCTION BY PHOTONS IN HYDROGEN. J.M.Sellen, G.Cocconi, V.T.Cocconi and E.L.Hart. *Phys. Rev.*, Vol. 113, No. 5, 1323-9 (March 1, 1959).

Pictures of a H_2 diffusion cloud chamber with magnetic field taken at the 1.1 BeV Cornell synchrotron were analysed to study multiple meson production by photons on protons. They yielded 108 cases of double charged meson production ($\gamma + p \rightarrow p + \pi^+ + \pi^-$) and 4 cases of triple meson production. For each event of double meson production, the energy of the incoming photon and the angles and momenta of the emitted particles could be determined. The cross-section for double charged meson production was found to rise rapidly around 500 MeV to approximately 70 microbarns, a value of the same order as the total cross-section for single meson production. In the reaction leading to a charged meson pair, π^+ and π^- play dissimilar roles, as evidenced by the marked dissimilarities in their centre-of-mass angular and momentum distributions. The Q-distributions suggest the interpretation that the predominant mode of pair production in the energy range from 500 to 700 MeV is $N^* + \pi^-$, $N^* \rightarrow p + \pi^+$, where N^* likely is the resonant $\frac{3}{2}, \frac{3}{2}$ excited state of the proton. The fact that the angular distributions for the protons and the π^- mesons

are asymmetric about 90° indicates that the reaction does not derive from a single state, but from a mixture of at least two interfering states of different parity.

539.12

6035. PHOTOPRODUCTION OF POSITIVE PIONS IN HYDROGEN IN THE ANGULAR RANGE $7^\circ < \theta_{c.m.} < 27^\circ$ AND PHOTON ENERGY RANGE $220 \text{ MeV} < k < 390 \text{ MeV}$.

A.J.Lazarus, W.K.H.Panofsky and F.R.Tangherlini.
Phys. Rev., Vol. 113, No. 5, 1330-8 (March 1, 1959).

Relative measurements of the cross-sections for the production of positive pions were carried out for four photon energies from 220 to 390 MeV. Positive pions were detected via the decay positron from $\pi^+ \rightarrow \mu^+ + e$ chain which was observed in a series of gates following a pulse of photons and electrons from the linear accelerator. The results are compared with new dispersion theory calculations using a range of values of the coupling constant and resonance energy. The experimental data at these small angles are in good agreement with the calculations; however, the fit of the calculations with available data at larger angles is not satisfactory. It is shown that the fit in either case is substantially poorer if the so-called "retardation term", i.e., the diagram in which the photon is absorbed by a virtual meson, is omitted.

539.12

6036. STUDY OF NEUTRAL PION PRODUCTION IN PROTON-PROTON COLLISIONS.

C.York, R.March, W.Kernan and J.Fischer.
Phys. Rev., Vol. 113, No. 5, 1339-43 (March 1, 1959).

A large lead glass Cherenkov counter was used to measure the energy spectrum of gamma-rays resulting from neutral pions produced in proton-proton collisions. A liquid hydrogen target was bombarded with protons of 447, 415, and 397 MeV. Gamma-rays emitted at 90° to the incident proton beam were detected by a counter telescope comprising an anticoincidence counter, a $\frac{1}{8}$ in. lead converter, two coincidence counters, and the lead glass counter. Pulses from the lead glass counter were fed through a gating circuit into a 100-channel pulse-height analyser. The three pulse-height spectra obtained were compared with those predicted from the phenomenological theory, to estimate the contributions of the various possible final angular momentum states. It is found that the spectra are consistent with isotropic emission of the π^0 's in the centre-of-mass system. The differential cross-sections for π^0 production are 12.6 ± 2.0 , 9.0 ± 1.9 , and 7.4 ± 1.7 microbarns/sterad at 445, 415, and 397 MeV, respectively.

539.12

6037. NEUTRAL K MESON AS A PARTICLE MIXTURE.

W.B.Fowler, R.L.Lander and W.M.Powell.
Phys. Rev., Vol. 113, No. 3, 928-34 (Feb. 1, 1959).

This experiment was designed to demonstrate the recently predicted particle-mixture property of the neutral K meson. The prediction asserts that the neutral K meson contains a short-lived component, θ_1^0 , and a longer-lived component, θ_2^0 . The θ_2^0 should have the property that it regenerates the short-lived component and also produces hyperons upon traversing matter. Under proper conditions the observation of such mesons or hyperons demonstrates the produce mixture property. The neutral K mesons in this experiment were produced by 1.25 BeV/c π^- mesons striking a $4 \times 4 \times 12$ inch aluminium target. Neutral particles emitted from the aluminium at an angle of 5° with respect to the π^- beam travelled 9.3 ft to a propane bubble chamber operated in a 12 kilogauss magnetic field. A sweeping magnet removed charged particles from this beam. θ_1^0 mesons could interact in the walls of the chamber or in the liquid propane, yielding θ_1^0 meson and Λ^0 hyperon decays in the sensitive region of the chamber. Twenty thousand pictures, corresponding to about 3×10^5 pions incident on the aluminium, were scanned for V^0 events. About 14 Λ^0 decays and about 12 θ_1^0 decays were observed. Spurious sources of these decays were estimated to be negligible.

539.12

6038. $\bar{K}^0 - K^-$ MASS EXCESS.

A.H.Rosenfeld, F.T.Solmitz and R.D.Tripp.
Phys. Rev. Letters, Vol. 2, No. 3, 110-12 (Feb. 1, 1959).

Using a hydrogen bubble chamber 44 events $K^- + p \rightarrow \bar{K}^0 + n$ were observed in which the $\bar{K}^0$ decayed into $\pi^+ + \pi^-$. The momentum p_0 of the $\bar{K}^0$ can be computed from the decay and is insensitive to the $\bar{K}^0 - K^-$ mass difference. From the measured curvature the momentum p_- of the K^- is then calculated and hence the mass difference. This procedure gives a mass difference of $+(4.7 \pm 1.3) \text{ MeV}$. Four of the events gave rise to identifiable recoil protons produced by the

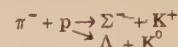
neutron. Using the proton angles and ranges these events gave a mass difference of $+(3.3 \pm 0.9) \text{ MeV}$. Combining the two results the $\bar{K}^0 - K^-$ mass difference is $+(3.7 \pm 0.7) \text{ MeV}$. This is of the opposite sign to that expected for a charge doublet. A.Ashmore

539.12

6039. $K^0 - K^+$ MASS EXCESS. F.S.Crawford, Jr, M.Cresti, M.L.Good, M.L.Stevenson and H.K.Ticho.

Phys. Rev. Letters, Vol. 2, No. 3, 112-13 (Feb. 1, 1959).

Production of K mesons by 1.12 GeV/c negative pions was observed in a hydrogen bubble chamber:



Examination of the dynamics of 16 $\Sigma^- K^+$ events and of 34 $\Lambda + K^0$ showed a discrepancy between the two types of event using currently accepted mass values. The discrepancy can be removed by assuming a $K^0 - K^+$ mass difference of $+(4.8 \pm 1.1) \text{ MeV}$. This has the opposite sign to that expected for a charge doublet and is three times too large if the mass difference is assumed to be purely electromagnetic and unaffected by strong interactions. A.Ashmore

539.12

6040. POSSIBLE DETERMINATION OF $K\Lambda$ RELATIVE PARITY.

L.Fonda and J.E.Russell.
Phys. Rev. Letters, Vol. 2, No. 2, 57-9 (Jan. 15, 1959).

It is suggested that if the $K\Lambda$ relative parity is odd, this could be detected from various correlation effects in the reactions $K^- + p \rightarrow \Lambda^0 + \pi^0 + \pi^0$ and $K^- + p \rightarrow \Lambda^0 + \pi^+ + \pi^-$ with slow K-mesons.

P.K.Kabir

539.12

6041. ABSORPTIONS OF NEGATIVE K-MESONS AT REST IN NUCLEAR EMULSION. IV. THE PION PRODUCING REACTIONS.

Y.Eisenberg, W.Koch, M.Nikolić, M.Schneeberger and H.Winzeler.
Nuovo Cimento, Vol. 11, No. 3, 351-76 (Feb. 1, 1959).

For previous part, see Abstr. 2644 (1959). This was studied in great detail, using a large emulsion block. Most of the secondary particles came to rest in the stack and were identified. Comparing the results with those previously obtained, and with the results obtained by Alvarez et al., the following conclusions may be drawn: (1) The single-nucleon reactions (pion producing captures) show a high rate of direct Λ -production. This result is a straightforward consequence of the observed sign fractions and absorption probabilities, if charge independence holds. It can be explained by the influence of the Fermi momentum. (2) The multi-nucleon (not producing pions) K^- -captures form a large fraction of the total K^- -captures at rest. It is estimated that as much as (35-50)% of the captures occur via the multinucleon channel. (3) Probably the single-nucleon K^- -captures at rest are mainly peripheral; thus they lead, because of geometrical reasons, to smaller pion and Σ -hyperon absorption probabilities.

539.12

6042. OBSERVATIONS OF K^- -MESON INTERACTIONS IN NUCLEAR EMULSION.

G.B.Chadwick, S.A.Durrani, P.B.Jones, J.W.G.Wignall and D.H.Wilkinson.
Phil. Mag. (Eighth Ser.), Vol. 3, 1193-212 (Nov., 1958).

23.6 metres of K^- -meson track in nuclear emulsion have yielded unbiased samples of 815 absorptions at rest and 106 in flight. The corresponding interaction mean free path is $21.5^{+1.3}_{-1.2} \text{ cm}$ for K^- -mesons of energy below 90 MeV. Observations are reported on the disintegration stars themselves and on the charged hyperons produced. It is in particular noted that the angular correlation between hyperon and pion in two-pronged stars is closely that expected for a system without any nuclear interaction in the final state. It is shown that this and other aspects of the situation are most simply explained if the K^- -meson is absorbed in the tenuous outer surface of the nucleus from a high Bohr orbit according to the model of Jones, and is not absorbed uniformly throughout the nuclear volume as is usually assumed. This surface absorption model allows of a strong hyperon-nucleon interaction such as appears to be indicated by a variety of other evidence and which would be inconsistent with the volume absorption model.

539.12

6043. K-MESON-NUCLEON TOTAL CROSS SECTIONS FROM 0.6 TO 2.0 BeV. H.C.Burrowes, D.O.Caldwell, D.H.Frisch, D.A.Hill, D.M.Ritson and R.A.Schluter.

Phys. Rev. Letters, Vol. 2, No. 3, 117-19 (Feb. 1, 1959).

A good-geometry attenuation experiment of K^+ -mesons in a liquid hydrogen target is described, and the following results noted.

The K^+ -proton total cross-section reaches a maximum of $4\pi (\hbar/m_Kc)^2$ at $P_{c.m.} \approx m_Kc$. The K^+ -proton and K^+ -nucleon total cross-sections are about the same in the energy range studied, compared with the K^- -proton cross-section which is roughly twice as large.

S.J.St-Lorant

539.12

6044. OPTICAL MODEL ANALYSIS OF ELASTIC SCATTERING OF 125 MeV K^+ MESONS IN NUCLEAR EMULSIONS.

M.A.Melkanoff, O.R.Price, D.H.Stork and H.K.Ticho.

Phys. Rev., Vol. 113, No. 5, 1303-8 (March 1, 1959).

The diffuse-surface optical model has been used to analyse the elastic scattering and interaction cross-section data obtained from 94 m of positive K-meson track in nuclear emulsion between energies of 100 and 150 MeV. The analysis was carried out on the SWAC digital computer through the use of the existing proton code which required but slight modification, such as the use of the Klein-Gordon equation. A thorough investigation was made of the number of energy intervals and representative emulsion nuclei that were required for adequate accuracy in the computed averaged cross-sections. This number was found to be one energy and two representative emulsion nuclei (heavy and light). The four parameters (R_0 , the radius parameter; a , the edge thickness; V , the real part of the potential; and W , the imaginary part of the potential) were varied and the goodness of fit was tested by means of the χ^2 probability, there being nine degrees of freedom. An attractive real potential is fairly clearly ruled out and good fits were obtained for a repulsive real potential for a fairly wide range of physically acceptable geometrical parameters. If the R_0 and a are chosen from electron-scattering experiments, then $V = 21 \pm 4$ MeV and $W = -11.0 \pm 1.5$ MeV. If R_0 is increased to 1.20×10^{-13} cm, then $V = 14 \pm 2.5$ MeV and $W = -7 \pm 1$ MeV.

539.12

6045. OPTICAL MODEL FOR THE SCATTERING OF K^- -MESONS BY NUCLEI. P.Mittelstaedt.

Z. Naturforsch., Vol. 12a, No. 12, 947-55 (1957). In German.

In the optical model, in addition to the Coulomb potential generated by protons there appears a complex potential $V = V_1 + iV_2$. The real and the imaginary parts of this potential are determined by adapting the theoretical results to the experimentally obtained values for the angular distribution of elastic scattering, and energy distribution of inelastically scattered K^- -mesons.

F.Lachman

539.12 : 539.17

6046. CAPTURE OF NEGATIVE K-MESONS IN COMPLEX NUCLEI. W.Alles.

Z. Naturforsch., Vol. 13a, No. 9, 740-5 (Sept., 1958). In German.

Of 2622 K^- capture stars found in Ilford G5 emulsion exposed to a 300 MeV/c K^- beam, 275 events are analysed in which a charged pion and a charged hyperon is emitted. 75% of the Σ^- hyperons end in zero-prong stars; together with previous work (Abstrs. 8185/1957, 8195/1957) this leads to a weighted mean for the ratio $\Sigma^-/\Sigma^+ = (66 \pm 10)\%$. Comparison of data on hyperon production by K^- mesons in bound protons ($\Sigma^-/\Sigma^+ = 1.14 \pm 0.17$) and in free protons indicated a mean Coulomb potential of $V_C = (8.4 \pm 2)$ MeV. The energy spectrum of the Σ hyperons corresponds to an attractive nuclear potential $V_\Sigma = -15$ MeV. The emission frequency of all charged hyperons gives estimates of the mean free paths of $\Sigma^\pm$ in nuclear matter, and hence limits on the effective Σ -nucleon interaction cross-sections.

S.J.St-Lorant

539.12

6047. V-A THEORY AND THE DECAY OF THE Λ HYPERON.

S.Okubo, R.E.Marshak and E.C.G.Sudarshan.

Phys. Rev., Vol. 113, No. 3, 944-54 (Feb. 1, 1959).

The decay of the Λ hyperon is studied within the framework of the chirality-invariant four-fermion interaction. It is shown that the branching ratio of the charged and neutral modes, the s- to p-wave emission, as well as the sign and magnitude of the asymmetry parameter of the $p + \pi^-$ decay mode, can be understood on the basis of the V-A theory. Improvements upon the Born approximation, using dispersion theory, indicate that these conclusions are not invalidated by taking into account the pion-nucleon interaction.

539.12

6048. Λ INTERACTIONS IN HYDROGEN. F.S.Crawford, Jr. M.Cresti, M.L.Good, F.T.Solmitz, M.L.Stevenson and H.K.Ticho.

Phys. Rev. Letters, Vol. 2, No. 4, 174-7 (Feb. 15, 1959).

655 Λ decays have been observed in a liquid hydrogen bubble chamber exposed to a π^- beam. The total Λ -particle path-length was 2200 cm. Four cases of elastic scattering and two of the process $\Lambda + p \rightarrow \Sigma^+ + n$ have been detected. The cross-sections are estimated to be 40 ± 20 mb and 30 ± 20 mb respectively.

S.J.Goldsack

6049. SCATTERING AND ANNIHILATION OF ANTIHYPERONS BY NUCLEONS. D.B.Lichtenberg.

Phys. Rev., Vol. 113, No. 5, 1309-10 (March 1, 1959).

A number of assumptions about the nature of antihyperon-nucleon forces are made which, if valid, allow the antihyperon-nucleon scattering and annihilation cross-sections to be given as simple linear combinations of the antiproton-proton and antineutron-proton cross-sections.

539.12

6050. DOUBLE ELASTIC SCATTERING OF DEUTERONS IN A MAGNETIC FIELD. O.D.Cheishvili and G.R.Khutsishvili.

Nuovo Cimento, Vol. 11, No. 3, 334-41 (Feb. 1, 1959).

The expression for the angular distribution of the double elastic scattering is obtained. The discussion is given of possible experiments on deuteron double elastic scattering with and without a magnetic field. It is shown that double elastic scattering in a magnetic field can give additional information about the scattering amplitude and the polarization in comparison with double scattering without a magnetic field.

NUCLEUS

539.14

6051. OPTICAL MODEL EVIDENCE FOR SURFACE ABSORPTION OF NEUTRONS. H.J.Amster.

Phys. Rev., Vol. 113, No. 3, 911-16 (Feb. 1, 1959).

Data-matching with the complex square well model for neutron scattering suggests that the imaginary part of the potential should be largest at the nuclear surface; such an effect is also in accord with present physical pictures of the interaction. However, when a diffuse edge is attached to the model and the other parameters are changed to provide experimental agreement, the need for surface absorption appears diminished. To investigate further, cross-sections resulting from a surface-absorbing and a uniformly absorbing potential, both with a diffuse edge, are calculated and compared. The results differ considerably less from each other than from the data, but the strength of absorption is more nearly independent of mass number when it is concentrated near the surface.

539.14

6052. THEORY OF THE SPIN-ORBIT INTERACTION IN NUCLEAR FORCES. S.N.Gupta.

Phys. Rev. Letters, Vol. 2, No. 3, 124-5 (Feb. 1, 1959).

The pion theory of nuclear forces seems unable to explain the large spin-orbit term in the nuclear potential, which seems to be necessary to fit nucleon-nucleon scattering data. The nucleon-nucleon potential resulting from the neutral scalar meson, which has recently been postulated by the author (Abstr. 2586, 2634/1959), is calculated in second order, and gives rise to a spin-orbit potential which is of the same form and strength as that used in the phenomenological potential of Signell, Zinn and Marshak (Abstr. 2679/1959).

E.J.Squires

539.14

6053. NUCLEAR FORCES WITH CENTRAL REPULSION AND THE SHELL MODEL OF THE NUCLEUS. SECOND ORDER EFFECTS. M.Moshinsky.

Rev. Mexicana Fis., Vol. 6, No. 4, 185-99 (Oct., 1957). In Spanish.

Bauer and Moshinsky (Abstr. 5253/1958) have shown that in nuclear shell theory, the effect of a hard core in the interaction potential between nucleons, could be eliminated by a simple translation, and instead, there appeared to first order the potential $4\pi(\hbar^2 a/m)\delta(r)$, where a is the range of the hard core and m the mass of the nucleon. Using the same method, the perturbation introduced by a hard core is calculated in this paper up to second order in a . The perturbation energy is obtained explicitly in the case where the common potential is a harmonic oscillator, and it is shown that the effect of a hard core, up to second order, still agrees with that of the δ function potential given previously. This result is compared with the analysis that Huang and Yang (Abstr. 3008/1957) give for free particles interacting through a hard core potential.

539.14 : 539.17

GAMMA-RAY ANGULAR CORRELATION TESTS FOR TIME-REVERSAL INVARIANCE IN NUCLEAR FORCES. See Abstr. 5034

539.14

6054. LOCALIZATION OF NUCLEONS IN THE O_8^{16} NUCLEUS.

L.P.Rapoport and Yu.M.Butusov.
Zh. eksper. teor. Fiz., Vol. 33, No. 6(12), 1507-8 (1957). In Russian.
English translation in: Soviet Physics — JETP (New York), Vol. 6(33), No. 6, 1163-4 (June, 1958).

The nuclear volume is divided into three trial sets of "boxes":
(a) three concentric spheres; (b) a sphere of given radius and separated into three zones: $0 \leq \Theta \leq x$; $x \leq \Theta \leq \pi - x$; $\pi - x \leq \Theta \leq \pi$;
(c) a tetrahedron with the nucleons localized at the vertices. The parameter relating the nucleon density and the probability of finding a nucleon in any given box is minimized; it is found that (a) gives the best representation. An upper limit for the diameter of a nucleon is estimated.
S.J.St-Lorant

539.14

6055. TABULATED MASS DIFFERENCES. V.A.Kravtsov.

Zh. eksper. teor. Phys., Vol. 33, No. 6(12), 1508-9 (1957). In Russian.
English translation in: Soviet Physics — JETP (New York), Vol. 6(33), No. 6, 1164-5 (June, 1958).

The author cites additional experimental evidence to correct the value given by King (Abstr. 2098/1955) for the energy released in the β decay of Mn^{56} . The weighted mean of all the data is 3.710 ± 0.011 MeV. This leads to a value for the binding energy of the neutron in Fe^{55} in agreement with experiment. The masses given by Quisenberry, Scolman and Nier (Abstr. 1527/1957) should be amended as follows: $Mn^{55} = 54.955512 \pm 8$, $Mn^{56} = 55.956700 \pm 8$, $Fe^{55} = 54.955761 \pm 8$.
P.G.Murphy

539.14

6056. THE NUCLEAR QUADRUPOLE MOMENT OF THE RADIO-ACTIVE ISOTOPES Cs^{135} AND Cs^{137} .

H.Bucka, H.Kopfermann and E.W.Otten.
Naturwissenschaften, Vol. 45, No. 24, 620 (1958). In German.

The excited $7^2P_{3/2}$ term of the neutral atom of the radioactive isotopes Cs^{135} and Cs^{137} (with $I = \frac{7}{2}$) was examined by means of the double-resonance method. The nuclear quadrupole moments found are:

$$Q(Cs^{135}) = +(0.049 \pm 0.01) \times 10^{-24} \text{ cm}^2$$

$$Q(Cs^{137}) = +(0.050 \pm 0.01) \times 10^{-24} \text{ cm}^2.$$

S.J.St-Lorant

539.14

6057. QUADRUPOLE MOMENTS OF THE EVEN ISOTOPES OF OSMIUM AND OF LUTETIUM¹⁷⁵. É.E.Berlovich.

Zh. eksper. teor. Phys., Vol. 33, No. 6 (12), 1522-3 (1957). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 6 (33), 1176-7 (June, 1958).

Results are given of measurements of the half-lives of the first excited states of the rotational bands of Os^{186} and Lu^{175} . The quadrupole moment of Os^{186} calculated from the half-life is $5.1 \times 10^{-24} \text{ cm}^2$, which is of the order of magnitude to be expected from comparison with neighbouring nuclei. For Lu^{175} a lower limit of $6.8 \times 10^{-24} \text{ cm}^2$ is found.
E.J.Squires

539.14 : 539.17

HIGH-ENERGY ELECTRON SCATTERING AND THE CHARGE DISTRIBUTION OF CARBON-12 AND OXYGEN-16.

See Abstr. 5052

539.14

6058. COULOMB EXCITATION OF SOME DEFORMED

u-g NUCLEI. M.Martin, P.Marmier and J. de Boer.
Helv. phys. Acta, Vol. 31, No. 5, 435-80 (1958). In German.

Excitation of the two first rotational levels of Au^{197} , Ta^{181} , Lu^{175} , Tm^{169} , Ho^{165} , Tb^{159} , Eu^{153} , ^{151} and Ag^{106} , ^{107} was studied using protons of 4.05 MeV. Spins, transition probabilities, and multipolarities, as well as moments of inertia, deformation parameters, and gyromagnetic factors were deduced from yields and angular distributions of the gamma-rays.

539.14

6059. THE EXCITED STATES AND β -TRANSITIONS OF SOME MEDIUM-LIGHT NUCLEI. R.P.Srivastav.

Z. Naturforsch., Vol. 12a, No. 9, 679-93 (Sept., 1957). In German.

An intermediate coupling shell model calculation is made of

some odd-parity excited levels in N^{16} , O^{16} and F^{16} , and of some allowed β -decays in this mass region. There is reasonable agreement with available experimental data.
R.J.N.Phillips

539.14

6060. NUCLEI LEVELS AND THE SHELL MODEL. C.Terreux.

Helv. phys. Acta, Vol. 31, No. 1, 45-68 (1958). In German.

Continuation of a previous paper (Abstr. 8775/1957). The principles of the graphic representation used are briefly summarized. All the low empirical levels for the region $N = 13-81$ with $Z = \text{even}$, $N = \text{odd}$ are graphically represented. The behaviour of these levels can generally be understood within the framework of the generalized spherical shell model (with configuration mixtures included.) A new discussion of the Bethe-Weizsäcker formula for the binding energy is given. The various contributions to the binding energy are interpreted in terms of the typical parameters of the shell model, such as depth and radius of the potential well, etc. The constant of the principal term of this formula, proportional to A , is determined theoretically from the nuclear radius only. The agreement with the empirical value of this constant is excellent. Nuclear radii are discussed in the light of the shell model.

539.14 : 539.17

6061. STUDY OF LEVELS IN O^{18} THROUGH THE RADIATIVE CAPTURE OF ALPHA PARTICLES BY C^{14} .

H.E.Gove and A.E.Litherland.

Phys. Rev., Vol. 113, No. 4, 1078-87 (Feb. 15, 1959).

Two resonances in the reaction $C^{14}(\alpha, \gamma)O^{18}$ have been studied at laboratory alpha-particle energies of 1.142 ± 0.010 and 1.790 ± 0.010 MeV. These correspond to excited states in O^{18} at 7.127 and 7.630 MeV. At the upper resonance only two primary transitions are observed leading to the ground state of O^{18} and the first excited state at 1.98 MeV. Their angular distributions along with other evidence unambiguously establish spins and parities of 1- for the 7.63 MeV state, 2+ for the 1.98 MeV state, and 0+ for the ground state. Values of $\gamma = \Gamma_{\alpha} \Gamma_{\gamma} / \Gamma$ of 80 and 160 millielectron volts, respectively, are obtained for the 7.63 and 5.65 MeV E1 primary transitions. At the lower resonance again only two primary transitions are observed leading to levels in O^{18} at 1.98 and 3.55 MeV. Greater than 96% of the decays of the 3.55 MeV level lead to the 1.98 MeV level. Analysis of the angular distributions of the four gamma-rays observed in the direct spectrum at this resonance, with respect to the incident beam, unambiguously establish spin and parity of 4+ to both the capturing state at 7.13 MeV and the level at 3.55 MeV. Values of γ of 15 and 12 millielectron volts, respectively, are obtained for the 3.58 MeV M1 and the 5.15 MeV E2 primary transitions. The amount of E2 mixing in the former transition is very small.

539.14 : 539.17

EXCITED STATES OF B^{10} . See Abstr. 5044

539.14 : 539.17

 Be^8 ENERGY LEVELS. See Abstr. 5046

539.14 : 539.17

EXCITED LEVELS IN C^{12} . See Abstr. 5064

539.14

6062. NUCLEAR RESONANCE FLUORESCENCE IN O^{16} .

B.Duelli and L.Hoffmann.

Z. Naturforsch., Vol. 13a, No. 3, 204-8 (March, 1958). In German.

The reaction $F^{19}(p, \alpha \gamma)O^{16}$ produces gamma rays by direct transitions from the excited levels at 7.12 MeV, 6.91 MeV and 6.14 MeV to the ground state of the O^{16} nucleus. Because of the recoil from the preceding alpha emission, there is a Doppler-shift of the gamma line, and resonance-fluorescence is to be expected if the effects of the Doppler shifts at emission and absorption can cancel. The experiments described show that the levels at 7.12 and 6.91 MeV can be excited in this way, but the level at 6.14 MeV cannot. From their measured reaction cross-sections, and from the calculated Doppler spectrum the authors have obtained a lower limit for the life-times of the two levels. These are compared with the prediction of the single particle model, and the alpha particle model.

S.J.Goldsack

539.14 : 530.145

MANY-BODY PROBLEMS. THEORY FOR AN INFINITE MEDIUM OF FERMIONS. See Abstr. 5371-2

RADIOACTIVITY

539.163 : 539.14
6063. ENERGY LEVELS IN Bi^{207} FROM THE DECAY OF Po^{207} .

E.Arbman, J.Burde and T.R.Gerholm.

Ark. Fys., Vol. 13, Paper 38, 501-38 (1958).

The energy levels in Bi^{207} were studied from the decay of 5.7 hr Po^{207} . The experiments include measurements of the energies and intensities of conversion electron lines and positron distributions in a double-focusing spectrometer; measurements of gamma-ray spectrum in a scintillation spectrometer and to some extent in the double-focusing spectrometer by the use of a lead converter; measurements of coincidences between pairs of conversion lines and between positrons and conversion lines in a double-lens coincidence spectrometer, and coincidences between positrons and gamma rays in a beta-gamma coincidence spectrometer. Two positron components of maximum energies 1140 and 893 keV were found, establishing the total decay energy of Po^{207} as 2.906 MeV. The proposed decay scheme contains 16 excited levels, 11 of which are considered to be well established. Spins and parities for the ground state of Po^{207} and the most strongly populated excited levels in Bi^{207} are given. The decay of Po^{207} is discussed on the basis of the shell model.

539.163 : 539.14
6064. EXTRANUCLEAR EFFECTS ON ANGULAR CORRELATIONS OF NUCLEAR RADIATIONS AND NUCLEAR MOMENTS OF EXCITED STATES. H.Narumi.

Doshisha Engng Rev., Vol. 9, No. 3, 109-29 (Oct., 1958). In Japanese.

Experiments of perturbed angular correlations were made by the Zürich group to find an electrostatic interaction between the electric hexadecapole moment of the excited state of Cd^{111} nucleus and the crystalline field with cubic symmetry (Abstr. 3109/1956). A new interpretation of this work is given by the introduction of an electric quadrupole interaction induced by lattice phonons, instead of a hexadecapole interaction. The present theory gives fairly good agreement quantitatively with the experimental results. Probable values of electric multipole moments of the above excited nucleus are calculated.

539.163
6065. THE SPECIFIC ACTIVITY OF RADIUM.
G.R.Martin and D.G.Tuck.
Internat. J. appl. Radiation and Isotopes, Vol. 5, No. 2, 141-5 (March, 1959).

A critical assessment has been made of the published information on disintegration energies in the radium series, and a value obtained for the mean energy deposition per radium disintegration in sealed sources of known history. This, when combined with Mann's (Abstr. 3993/1955) calorimetric measurements on the heating effects in several national primary radium standards prepared by Hönigschmid, gives a value for the specific activity of radium of 3.655×10^{10} disintegrations per second per gramme, corresponding to a disintegration constant of 4.326×10^{-4} per year, or a half-life of 1602 years.

539.163 : 530.145
6066. BETA-GAMMA CORRELATION AND TIME-REVERSAL INVARIANCE. I.Iben, Jr.
Phys. Rev., Vol. 112, No. 4, 1240-6 (Nov. 15, 1958).

The distribution function for the first-forbidden beta-gamma correlation for randomly oriented nuclei, including beta transverse polarization terms, is presented and discussed in connection with the question of time-reversal invariance. Coulomb field effects are included and it is found that even for relatively small Z the time-reversal testing asymmetry is reduced appreciably compared to that calculated for Z = 0 by Curtis and Lewis (Abstr. 2548/1958). In the limit of high ($\alpha Z/2R$), that is, for most first-forbidden decays, a definite relation exists between the ordinary directional correlation asymmetry and the beta polarization-dependent asymmetries. In the approximation it is found that terms which test time-reversal invariance appear in the same manner in all asymmetries but are dominated in general by contributions which do not test time-reversal invariance. For the particular case of Au^{198} it is shown that the experimental results are consistent with time-reversal invariance but are also consistent with an appreciable violation of time-reversal invariance. It is concluded that under favourable conditions it is barely possible that an investigation of the asymmetries for some other beta-gamma cascade could provide

a test for time-reversal invariance. However, the extent to which this invariance is or is not violated could not be determined by such an investigation.

539.163
6067. THE L-FLUORESCENCE YIELD OF Tl AND Bi IN THE $\text{Th(B-C-C')}^{\text{II}}$ DECAY. H.Winkenbach.
Z. Phys., Vol. 152, No. 4, 387-96 (1958). In German.

The L series X-ray spectrum associated with the thorium decay is studied by use of a proportional counter. From the mean intensity of the L radiation of the Th B and Th C specimens and known ionization of the L shell for Tl and Bi, values of the L-fluorescence yield are obtained. For Bi 0.4 ± 0.02 and for Tl 0.32 ± 0.02 are obtained for the yields. A value of the partial yield for the L_{111} shell of Tl is obtained as 0.33 ± 0.02 .

G.F.J.Garlick

539.163 : 539.17
Abstr. 5067
HALF-LIVES OF TWO NEW PROMETHIUM ISOTOPES. See539.163.1
6068. THE HALF-LIVES OF SOME ELECTRIC QUADRUPOLE TRANSITIONS IN THE LEAD REGION.
B.Johansson, T.Alväger and W.Zuk.
Ark. Fys., Vol. 14, Paper 27, 439-49 (1958).

Measurements of half-lives of isomeric nuclear states were carried out on electromagnetically isotope separated samples with a 25-channel time analyser. This analyser made it possible to investigate short-lived mother nuclei. In the cases below the half-lives of the mother nuclei varied from 1.5 up to 20 hr. The following half-lives were obtained:

1383 keV level of Pb^{208m} : $T_{1/2} = 2.0 \pm 0.15 \text{ m}\mu\text{s}$ 148 keV level of Tl^{200} : $T_{1/2} = 7.1 \pm 0.15 \text{ m}\mu\text{s}$ 173 keV level of Tl^{186} : $T_{1/2} = 4.5 \pm 1 \text{ m}\mu\text{s}$

For the following levels, an upper limit was determined:

367 keV level of Tl^{186} : $T_{1/2} \leq 1.5 \text{ m}\mu\text{s}$ 330 keV level of Tl^{201} : $T_{1/2} \leq 1.5 \text{ m}\mu\text{s}$

In all measurements NaI(Tl) scintillation detectors were used.

539.163.1
6069. SEARCH FOR AN 80 mSEC ACTIVITY IN LIGHT NUCLEI.
D.E.Alburger, A.Elwyn, A.Gallmann, J.V.Kane, S.Offer and R.E.Pixley.
Phys. Rev. Letters, Vol. 2, No. 3, 110 (Feb. 1, 1959).

The 80 msec activity resulting from capture of π^- mesons in carbon, reported by the CERN group, has been sought without success in the products of (n,p) reactions in Li, Be, B, B^{10} and C with d-t neutrons. Upper limits for (n,p) cross-sections leading to an 80 msec high energy β -emitter are given for Li, Be, B^{11} , B^{10} and C as 1.2, 4, 50, 0.8 and 2 millibarns respectively.

A.E.I. Research Laboratory

539.163.1
6070. LIFETIME OF THE 264 keV LEVEL OF Er^{167} .
É.E.Berlovich, K.M.Grotovskii, M.P.Bonits and G.M.Gorodinskii.
Zh. eksper. teor. Fiz., Vol. 33, No. 6(12), 1523-4 (1957). In Russian.
English translation in: Soviet Physics — JETP (New York), Vol. 6(33), No. 6, 1177-8 (June, 1958).

Coincidence techniques were used to determine the lifetime of the 264 keV level and partial γ -decay periods calculated for the mixed γ -transition to the 207 keV level. These periods lead to a possible discrepancy with the assumption that the nucleus is strongly deformed with these levels as members of the same rotational band.

C.J.Batty

539.163.2
6071. 25-MINUTE ISOMER OF Se^{83} .
R.G.Cochran and W.W.Pratt.
Phys. Rev., Vol. 113, No. 3, 852-6 (Feb. 1, 1959).

Se^{83} was produced by irradiation of a selenium sample enriched to 75% in the Se^{82} isotope, in a research reactor. The gamma-ray spectrum of the 25-minute isomer was investigated by means of a 3 in. thick $\times$ 3 in. diameter NaI(Tl) crystal scintillation spectrometer. Gamma-rays of energy $2.294 \pm 0.030 \text{ MeV}$, $1.880 \pm 0.015 \text{ MeV}$, $1.309 \pm 0.005 \text{ MeV}$, $1.058 \pm 0.005 \text{ MeV}$, $0.833 \pm 0.005 \text{ MeV}$, $0.712 \pm 0.010 \text{ MeV}$, $0.524 \pm 0.012 \text{ MeV}$, $0.358 \pm 0.005 \text{ MeV}$, and $0.225 \pm 0.005 \text{ MeV}$ were found. The beta-ray spectrum was investigated by means of a plastic scintillator. In order to eliminate a competing activity from Se^{81} it was found essential to restrict the observation

of beta-rays to those in coincidence with the Se^{83} gamma-ray spectrum. A coincidence circuit of 0.25 microsecond resolving time was developed for this purpose. The beta-ray spectrum was found to be complex with end-point energies of approximately 0.45 MeV, 1.0 MeV, and 1.7 MeV. From these data, together with gamma-gamma coincidence measurements, a decay scheme is proposed.

539.163.2

6072. RADIATIONS FROM Ba^{129} . W. Henkes.
Phys. Rev., Vol. 113, No. 3, 863-5 (Feb. 1, 1959).

The decay of Ba^{129} produced by an (n,2n) reaction was investigated. A new half-life value of 2.45 ± 0.05 hours is reported. Gamma-rays of 1.45, 0.210, 0.182, and 0.127 MeV with relative intensities 42, 65, 100, and ~26 were found, with coincidences between the 1.45 MeV and 0.182 MeV gammas. Milking experiments showed 25% to 30% of Ba^{129} to decay by β^+ emission, based on assumptions about the unknown decay scheme of Cs^{129} . This result is compatible with the intensities of K X-rays, positrons, and the various gamma-rays only if unobserved γ - γ coincidences are postulated in addition to the reported ones. The result of the milking experiments is also in contradiction to the calculated K/ β^+ ratio. 19% of the observed β^+ transitions are in coincidence with the 0.210 and 5.6% with the 0.127 MeV gamma-rays. Because of the mentioned discrepancies, no decay scheme can be proposed.

539.163.2

6073. DECAY OF As^{74} .

D.J. Horen, W.E. Meyerhof, J.J. Kraushaar, D.O. Wells, E. Brun and J.E. Neighbor.

Phys. Rev., Vol. 113, No. 3, 875-80 (Feb. 1, 1959).

The decay of As^{74} (17.5-day) was reinvestigated with single and coincidence scintillation spectrometers. The singles spectrum revealed previously unknown gamma-rays of 1.19 ± 0.01 , 1.60 ± 0.04 , and 2.22 ± 0.02 MeV. X-ray-gamma coincidence measurements indicate the 1.19 MeV gamma-ray is predominantly associated with the decay to Ge^{74} . Evidence is found for 0.6-0.6 MeV gamma-gamma coincidences in Ge^{74} . Based on these data, a level scheme for Ge^{74} is presented with excited states at 0.596, 1.19, and 2.22 MeV. No new information concerning the decay to Se^{74} has been gained.

539.163.2

6074. DECAY OF Nb^{92} .

H.I. West, Jr., L.G. Mann and G.M. Iddings.

Phys. Rev., Vol. 113, No. 3, 881-5 (Feb. 1, 1959).

The decay scheme of Nb^{92} was re-examined. Levels at 0.934 MeV (97.4% per disintegration) and 1.82 MeV (2.6%) were found. The 1.82 MeV state decays by 32% to the ground state and 68% to the 0.934 MeV state. This is in agreement with the work of Hayward, Hoppes, and Ernst [Phys. Rev., Vol. 98, No. 1, 231 (April 1, 1955)]. In addition a weak positron branch of $(5.6 \pm 0.6) \times 10^{-30}$ per disintegration was found going to the 0.93 MeV level. Also, the angular correlation of the gamma-ray cascade was measured and found to be uniquely consistent with a level assignment of 2^+ , 2^+ , 0^+ , with essentially pure M1 radiation (E2 admixture < 0.2%) for the 2^+ , 2^+ transition. The large amount of M1 radiation in this type of transition is quite exceptional. Simple theoretical considerations indicate the gamma-ray transitions to be of the single-particle type.

539.163.2

6075. DECAY OF Pm^{143} AND Pm^{144} . S. Ofer.

Phys. Rev., Vol. 113, No. 3, 895-9 (Feb. 1, 1959).

Radioactive Pm^{143} and Pm^{144} were produced by the bombardment of Pr^{141} with α -particles. Gamma-rays at 475 keV, 610 keV, and 695 keV are found to be associated with the decay of Pm^{144} by K-capture to Nd^{144} . A 740 keV gamma transition is associated with the decay of Pm^{143} by K-capture to Nd^{143} . Levels of Nd^{144} are placed at 695 keV (2^+), 1305 keV (4^+), and 1780 keV (6^+) above the ground level. Assignments of spins of levels and multiplicities of gamma-ray transitions are based on the results of measurements of conversion coefficients and gamma-gamma angular correlations. A value of $(13 \pm 4) \times 10^{-11}$ sec was found for the mean life of the 1305 keV level of Nd^{144} . An upper limit of 3×10^{-11} sec was found for the mean life of the 695 keV level of Nd^{144} .

539.163.2 : 539.17

6076. REACTION $\text{A}^{40}(\text{p,n})\text{K}^{40}$ AND THE DECAY OF K^{40} .
R.E. Holland and F.J. Lynch.

Phys. Rev., Vol. 113, No. 3, 903-8 (Feb. 1, 1959).

The energy difference involved in the decay of K^{40} to A^{40} by electron capture was measured in two ways. First, a time-of-flight

technique was used to observe the neutron spectra from $\text{A}^{40}(\text{p,n})\text{K}^{40}$ and the corresponding Q's were computed. Second, the thresholds for production of certain gamma rays from this reaction were measured; these thresholds provided another set of values for the Q's. When these Q values were combined with the measurements of the gamma-rays energies, a mass difference was obtained equivalent to 1.522 ± 0.006 MeV between A^{40} and K^{40} and an energy release of 60 ± 8 keV in the decay of K^{40} to A^{40} . This appears to conflict with other information on this branch of the decay of K^{40} .

539.163.2

6077. DISINTEGRATION SCHEME OF LONG-LIVED ALUMINUM-26. R.A. Rightmire, J.R. Simanton and T.P. Kohman.
Phys. Rev., Vol. 113, No. 4, 1069-77 (Feb. 15, 1959).

The maximum positron energy as determined by absorption measurements is 1.16 ± 0.05 MeV; this agrees with the expected 1.17 MeV. The spectrum appears to be simple. The scintillation gamma-spectrum shows intense positron annihilation radiation, a strong peak at 1.83 ± 0.03 MeV, and weak peaks at 1.12 ± 0.03 MeV, corresponding to transitions from the known Mg^{26} states at 1.82 and 2.97 MeV. A peak at 0.68 MeV is from the addition of two annihilation photons, one being backscattered from the source and surroundings; the gamma of ~0.7 MeV energy reported by others is not present. The peak at 2.97 MeV is shown to result from 2.97 MeV photons as well as from addition of 1.82 and 1.15 MeV photons. The relative intensities of the annihilation and gamma radiations indicate that Al^{26} undergoes $(84.6 \pm 1.8)\%$ positron emission to the 1.82 MeV state of Mg^{26} ; $(11.4 \pm 1.9)\%$ electron capture to the same state; $(3.7 \pm 0.3)\%$ electron capture to the 2.97 MeV state followed by emission of 1.15 MeV gamma-rays; and $(0.30 \pm 0.03)\%$ electron capture to the same state followed by 2.97 MeV radiation. Other energetically possible transitions are apparently negligible in intensity. Auger electrons and X-rays were observed in a proportional counter spectrometer. Analysis of the spectra yielded K-shell fluorescence yields of 0.008 ± 0.003 for magnesium and 0.008 ± 0.003 for aluminum.

539.163.2

6078. DECAY OF 13-HOUR Re^{182} .

C.J. Gallagher, Jr., J.O. Newton and V.S. Shirley.

Phys. Rev., Vol. 113, No. 5, 1298-302 (March 1, 1959).

An electron- and gamma-spectroscopic study of the levels of W^{182} populated by the 13 hr electron-capturing isomer Re^{182} has been made. The levels observed support previous studies on the W^{182} levels as observed in Ta^{182} decay. Evidence for weakly populated levels around 2 MeV is reported, which indicates that the decay energy of the isomer is greater than 2 MeV. On the basis of the spins and parities of the levels populated, the isomer is assigned spin 3, negative parity.

539.163.2

6079. COINCIDENCE STUDIES IN THE DECAY OF Tb^{158} AND Tb^{154} .

R.W. Henry, L.T. Dillman, N.B. Gove and R.A. Becker.

Phys. Rev., Vol. 113, No. 4, 1090-4 (Feb. 15, 1959).

Tb^{158} (5.35 days) and Tb^{154} (7.5 hours and 21.5 hours) were produced by (γ, n) and $(\gamma, 5\text{n})$ reactions on stable Tb^{159} . In addition, Tb^{158} was produced by a $(\text{p}, 2\text{n})$ reaction on stable Gd^{157} . Gamma rays at 89 ± 1 , 200 ± 2 , 261 ± 5 , 300 ± 10 , 358 ± 5 , 420 ± 5 , 535 ± 3 , 1050 ± 10 , 1140 ± 10 , 1210 ± 10 , 1410 ± 10 , 1630 ± 20 , and 1830 ± 20 keV were associated with the 5.35-day activity, and 88 ± 1 , 123 ± 3 , 180 ± 5 , 250 ± 3 , 340 ± 10 , 511 ± 10 , 640 ± 15 and others greater than 1600 keV were associated with 21.5 hour and shorter activities. Levels of Gd^{156} are placed at $89(2^+)$, $289(4^+)$, 1140, 1500, and 2035 keV above the ground state. These follow electron capture in 5.35-day Tb^{158} . The K-shell conversion coefficients of the 89 and 200 keV transitions are determined to be about 1.0 and 0.16, respectively.

539.163.2

6080. DISINTEGRATION SCHEME AND β -SPECTRUM OF MESOTHORIUM I (Ra^{228}). G. Goetze and E. Huster.

Z. Naturforsch., Vol. 13a, No. 9, 796-7 (Sept., 1958). In German.

Results are in good agreement with those of Lee and Libby (Abstr. 1104/1939) and a single β line with maximum energy of 55 ± 3 keV.

J.M. Hough

539.164

6081. ALPHA-UNSTABLE EXCITED STATES OF Be^8 .

V. Meyer and H.H. Staub.

Helv. phys. Acta, Vol. 31, No. 3, 205-20 (1958). In German.

The energy distribution of α -particles resulting from the decay of Be^8 following the reaction $\text{Li}^7(\text{p}, \gamma)\text{Be}^8$ was measured with a magnetic spectrograph in coincidence with the γ -rays and also singly.

The well-known first excited state appears at a reduced energy of 2.8 MeV with a width of 1.9 MeV. No evidence of a fine structure of this level could be found. On the high-energy side, for excitation energies between 4 and 9 MeV, no levels are present with intensities of more than 2% of the total number of excited Be⁹ nuclei.

539.164

6082. NATURAL RADIOACTIVITY OF LEAD-204 AND THE QUESTION OF NATURAL ACTIVITY OF DYSPROSIUM-156.

W.Riezler and G.Kauw.

Z. Naturforsch., Vol. 13a, No. 10, 904-5 (Oct., 1958). In German.

Measurements were carried out with enriched isotopes. The half-life for α -decay of Pb²⁰⁴ was found to be 1.4×10^{17} years and the energy is 2.6 MeV. The negative result for Dy¹⁵⁶ gives a half-life greater than 10^{18} years.

G.E.Brown

539.165

6083. INTERNAL PAIR EMISSION AT SMALL ANGLES.

G.Golding.

Proc. Phys. Soc., Vol. 73, Pt 4, 556-60 (April, 1959).

The process of electron positron pair emission in nuclear electromagnetic transitions is investigated in the special case where the angle between the directions of emission of the electron and positron is small. It is shown that experimentally this process can be of value in determining the absolute emission rates of high energy γ -rays.

539.165

6084. ON THE BETA SPECTRUM AND DISINTEGRATION ENERGY OF Sr⁹⁰ AND Y⁹⁰.

V. Hovi.

Ann. Acad. Sci. Fennicae A VI, No. 21, 12 pp. (1959).

Values for the mean energy E_β were determined by using different approximations of the shape correction factor and available spectroscopic data. It is shown that for Sr⁹⁰, the theoretical mean energies corresponding to different approximations of the shape correction factor differ so much from each other that, by using modern microcalorimetric techniques at low temperatures, it would be possible to get an independent verification of the shape factor. This might be important for elucidating the actual form of the interaction in beta-decay. In the case of Y⁹⁰, because of the small relative differences between the values of E_β , independent calorimetric verification could hardly lead to as significant results.

539.165

6085. ON THE BETA SPECTRUM AND DISINTEGRATION ENERGY OF RaE, Cl³⁶, AND Ni⁶³.

V. Hovi and I. Laakso.

Ann. Acad. Sci. Fennicae A VI, No. 26, 10 pp. (1959).

Values for the mean energy were calculated. In the case of RaE the mean energy was determined from the experimental beta spectrum. The value obtained was in good agreement with the earlier calorimetric result. For Cl³⁶, certain mean energies corresponding to the theoretical analysis of Longmire, Wu, and Townes (Abstr. 1178/1950) were calculated. These energies exhibited a marked spread. Thus, an independent calorimetric verification would be interesting. In the case of Ni⁶³, the values of the mean energy were calculated for an allowed and for a first forbidden α -shape. Both these shapes have been previously suggested by spectroscopic experiments. By carrying out independent calorimetric measurements at low temperatures, it should be possible to distinguish between these two shapes.

539.165

6086. THE BETA RAYS OF PRASEODYMIUM-144 AND THE AXIAL VECTOR BETA INTERACTION.

N.J. Freeman.

Proc. Phys. Soc., Vol. 73, Pt 4, 600-8 (April, 1959).

The shapes, intensities and end-points of the three strong components of the Pr¹⁴⁴ beta-spectrum were measured with a prolate spheroidal field spectrometer and coincidence techniques. A spin of 0⁻ has been assigned to the ground state of Pr¹⁴⁴ on the basis of these measurements. It is shown that the pure axial vector correction factor for a $\Delta I = 0$ (yes) transition provides a good fit to the ground state spectrum. The spectrum of the β -transition to the 695 keV level in Nd¹⁴⁴ has a unique first forbidden shape.

539.165

6087. SELF-ABSORPTION OF β -RADIATION BY MEASUREMENTS WITH A 4π -COUNTER.

H. Meister.

Z. Naturforsch., Vol. 13a, No. 9, 722-40 (Sept., 1958). In German.

The β -emitter was covered by metal foils of varying thicknesses and the resulting activities measured in a 4π -counter whose construction and operation are described. Linear extrapolation to zero thickness gives the activity in the absence of self-absorption, and comparison with the observed thickness-counting rate curve gives the

self-absorption. Tabulated results are presented for a range of β -ray energies from the following elements: Mn⁵⁶, Cu⁶⁴, Pd¹⁰⁹, In¹¹⁶ and Au¹⁹⁸.

J.W.Gardner

539.165 : 539.12

INVERSE BETA DECAY AND THE TWO-COMPONENT NEUTRINO.

See Abstr. 5990

539.165.07

6088. A SIMPLE AND COMPACT ARRANGEMENT FOR MEASURING THE β -ACTIVITY OF WEAK RADIOACTIVE SAMPLES.

K. van Duuren.

Philips tech. Rev., Vol. 20, No. 6, 170-2 (1958-59).

The lower limit to the detection of beta radiation is largely governed by the background counts of the detector, i.e. the pulses per unit time caused by stray gamma radiation and mesons of cosmic radiation. The influence of neighbouring gamma radiation can be effectively suppressed by shielding, preferably consisting of mercury surrounded by iron. To eliminate the effect of the mesons it was hitherto necessary to use a large number of guard counters in an anti-coincidence circuit. A method is described in this article using only one guard counter tube, of a type developed by Philips, fitted around a central counter. This assembly is much smaller and hence the weight of the massive shielding can be considerably reduced. Also the layout and the electronic equipment are much simplified. In a particular case the background counts were reduced to 0.7 per minute.

539.165.08

6089. ON THE RADIOACTIVE BETA DISINTEGRATION ENERGY OF P³², S³⁵, Pm¹⁴⁷, Ca⁴⁵, AND Pr¹⁴³.

V. Hovi.

Ann. Acad. Sci. Fennicae A VI, No. 16, 14 pp. (1959).

A survey is presented of the calorimetric radioactivity measurements carried out since the review article by Myers (Abstr. 1641/1950). The data obtained previously by means of different methods for the mean energy, $\bar{E}_\beta$, of the beta particles of P³² and S³⁵ have been re-examined. It is shown that all the modern values of $\bar{E}_\beta$ determined from the beta spectra, calorimetric measurements, and from the Fermi theory are in good agreement. For Pm¹⁴⁷, Ca⁴⁵, and Pr¹⁴³ predictive values of $\bar{E}_\beta$ have been calculated from the available beta spectrum (Pm¹⁴⁷), and from the Fermi theory (Pm¹⁴⁷, Ca⁴⁵, and Pr¹⁴³). These predictive values are important for future precision calorimetric investigations at low temperatures.

539.165.2

6090. CALCULATION OF SOME RELATIVISTIC CORRECTIONS TO THE ALLOWED AND i -FORBIDDEN BETA TRANSITIONS.

G. Alaga, L. Šips and D. Tadić.

Period. math.-phys. astron. (Zagreb), Vol. 13, No. 2, 139-57 (1958).

This paper contains a fuller account of results previously reported (Abstr. 6263/1958).

E.J.Squires

539.165.2

6091. THE ANGULAR CORRELATION AND POLARIZATION OF β -RAYS IN SINGLET TRANSITIONS.

B. Kuchowicz.

Z. Naturforsch., Vol. 13a, No. 11, 999-1001 (Nov., 1958). In German.

Expressions for the polarization of electrons in recoil experiments are given for allowed transitions ($\Delta J = \pm 1$) and for first forbidden transitions ($\Delta J = \pm 2$). Such experiments may distinguish between axial-vector and tensor interactions. The possibility of testing time-reversal invariance is also considered.

S.J.St-Lorant

539.166

6092. CONTRIBUTION TO THE STUDY OF GAMMA TRANSITION PROBABILITIES BY THE DELAYED-COINCIDENCE METHOD.

H. Vartapetian.

Ann. Phys. (Paris), Ser. 13, Vol. 3, No. 7-8, 569-628 (July-Aug., 1958). In French.

Describes an experimental investigation of certain E1 transitions in Lu¹⁷⁵, Hf¹⁷⁷, Ra²²³ and Pa²³⁴, and M1 transitions in Cs¹³¹ and Pa²³⁴. Some of the lifetimes measured are of the order of 10^{-9} sec. The results are discussed in relation to other experiments and theoretical ideas.

R.J.N. Phillips

539.166

6093. ELECTROMAGNETICALLY PERTURBED GAMMA ANGULAR DISTRIBUTIONS OF THE 197 keV TRANSITION IN F¹⁹.

M. Martin, R. Szostak and P. Marmier.

Helv. phys. Acta., Vol. 31, No. 5, 481-90 (1958). In German.

The perturbation of the angular distribution of the 197 keV gamma rays following inelastic scattering of protons in F¹⁹ was measured as a function of an external magnetic field for some solid and liquid targets. The influence of electric quadrupole perturba-

tions is discussed and a value of (3.5 ± 0.5) nuclear magnetons for the magnetic moment of the 197 keV state was determined.

6094. THE γ -SPECTRUM OF Cr^{51} . L.Bambe and L.Pelekis. Latv. PSR Zinat. Akad. Vestis, No. 8(121), 127-8 (1957). In Russian. The relative intensity of the 323 and 630 keV lines was found to be $1 : 2.7 \times 10^{-3}$. W.O.Lock

6095. DIRECTIONAL CORRELATION OF GAMMA RAYS FOLLOWING THE DECAY OF Eu^{152} . R.W.Lide and M.L.Wiedenbeck. Phys. Rev., Vol. 113, No. 3, 840-4 (Feb. 1, 1959).

Directional correlation measurements were made on the 245 keV-122 keV, 969 keV-122 keV, 1118 keV-122 keV, 1416 keV-122 keV, 872 keV-245 keV, and 1170 keV-245 keV cascades in Sm^{152} , and on the 782 keV-345 keV cascade in Gd^{152} . The spins of Sm^{152} are found to be 0, 2, 4, 2, 3, 3, for the ground, 122 keV, 367 keV, 1092 keV, 1240 keV, and 1538 keV levels. The 245 keV gamma-ray is found to be pure quadrupole; the 872 keV gamma-ray is 98% quadrupole, 2% dipole; the 969 keV gamma-ray is 98% quadrupole, 2% dipole; the 1118 keV gamma-ray is 99.8% quadrupole, 0.2% dipole; the 1170 keV gamma-ray is 98% quadrupole, 2% dipole; the 1416 keV gamma-ray is 15% quadrupole, 85% dipole. In Gd^{152} the spin of the 1127 keV level is found to be 3 and the 782 keV gamma-ray is found to be pure dipole. A spin assignment of 1, 2, or 3 for the 757 keV level would not be inconsistent with the data. For any of these cases the 412 keV gamma-ray must be mostly dipole; the quadrupole content must be less than 15%.

6096. COULOMB CORRECTIONS IN THE THEORY OF INTERNAL BREMSSTRAHLUNG. L.Spruch and W.Gold. Phys. Rev., Vol. 113, No. 4, 1060-8 (Feb. 15, 1959).

The internal bremsstrahlung associated with allowed β -decay is calculated for the case for which the gamma-ray energy is less than $2mc^2$, the kinetic energy of the electron in its final state is small compared to mc^2 , and Ze^2/hc is small compared to 1. It is not assumed that $(Ze^2/hc)mc$ is small compared to the final momentum of the electron, or to the gamma-ray momentum. Results are obtained for the gamma-ray energy spectrum and for the angular correlation between the electrons and the gamma-rays. For S^5 , for which the above assumption would seem to be satisfied, the agreement between theory and experiment for the number of gamma-rays per β disintegration per mc^2 is better than that previously obtained; because of uncertainties in the experimental results, the extent of the improvement is not clear. Under the additional assumption that the final kinetic energy of the electron is small compared to the gamma-ray energy, an expression is derived for the polarization of the gamma-rays.

6097. CIRCULAR POLARIZATION OF THE INTERNAL BREMSSTRAHLUNG IN THE K-CAPTURE OF A^{37} . G.Hartwig and H.Schopper. Z. Phys., Vol. 152, No. 3, 314-18 (1958). In German.

This effect was measured for various energies of the photons. In the investigated spectral range a full polarization was found within the measurements errors, and a mean value $P_C = -1.03 \pm 0.04$ obtained. This indicated parity violation in K-capture processes. G.Martelli

6098. NUCLEAR RESONANCE FLUORESCENCE IN Mg^{24} . R.G.Arns, R.E.Sund and M.L.Wiedenbeck. Phys. Rev. Letters, Vol. 2, No. 2, 50-1 (Jan. 15, 1959).

The resonance scattering of the 1.38 MeV γ -ray following the decay of Na^{24} was observed by making use of the preceding 2.76 MeV γ -ray to restore the resonance condition. The self-absorption of this γ -ray suggests that the level width is about 7×10^{-4} eV. M.A.Grace

6099. ABOUT THE DECAY OF THE PALLADIUM ISOMERS Pd^{106m} AND Pd^{109m} . T.Stribel. Z. Naturforsch., Vol. 12a, No. 11, 939-40 (1957). In German.

The isomers were produced by irradiating palladium metal with neutrons from a lithium target. The γ -radiation from the isomers was examined by a γ -scintillation spectrometer. By examining the γ -ray spectrum at various times after irradiation, it was possible to determine the half-lives, the γ -ray energies and the κ -conversion coefficients for both the isomers. D.H.Lord

6100. A NOTE ON THE ISOBAR SERIES 107 AND 108.

F.Baumgärtner, A.P.Bedmar and L.Kindermann.

Z. Naturforsch., Vol. 13a, No. 1, 53 (Jan., 1958). In German.

A study of the γ -rays of Rh^{107} , Rh^{108} , Ru^{107} , Ru^{108} has made possible a clarification of the characteristics of the β -spectra of these nuclei. L.Pincherl

- MEASURING γ -RAY SPECTRA WITH LARGE PLASTIC SCINTILLATORS. See Abstr. 5972

6101. LOW-LEVEL GAMMA RAY DETECTION IN HUMANS.

E.C.Anderson and M.A.Van Dilla.

I.R.E. Trans Nuclear Sci., Vol. NS-5, No. 3, 194-8 (Dec., 1958).

6102. USING NUCLEAR METHODS IN OIL-WELL LOGGING.

R.L.Caldwell.

Nucleonics, Vol. 16, No. 12, 58-65 (Dec., 1958).

The use of γ -detectors of natural radioactivity, measurement of the intensity of scattered radiation originating from a γ -source and the use of neutron sources either by detection of scattered neutrons or by measurement of induced activity is reviewed. Measurements of density, porosity, water content and chemical analysis are possible. A bibliography is included. R.D.Smith

6103. NEUTRON-CAPTURE GAMMA RAYS IN Cl^{36} . R.E.Segel.

Phys. Rev., Vol. 113, No. 3, 844-51 (Feb. 1, 1959).

γ - γ coincidences on the gamma-rays following thermal neutron capture in Cl^{35} were measured. Combining these results with the energy levels in Cl^{36} known from the $\text{Cl}^{35}(\text{d},\text{p})\text{Cl}^{36}$ reaction and the $\text{Cl}^{35}(\text{n},\gamma)\text{Cl}^{36}$ gamma-ray spectrum measured by other workers, a decay scheme is constructed which unambiguously places most of the known gamma rays in Cl^{36} . An examination is made of the reduced widths of gamma-rays emanating from the capturing state, and it is shown that the reduced widths for gamma-rays of the same multipolarity can fluctuate widely, and that these fluctuations do not appear to be correlated with the final-state shell model configuration. It is also shown that the reduced widths for E1 and M1 transitions emanating from the capturing state are significantly smaller than those calculated from the single-particle estimate, and that E1 transitions are more intense than M1 transitions by about a factor of four. Evidence is presented for there being collective motion present in some of the higher excited states in Cl^{36} .

NUCLEAR REACTIONS

6104. EMISSION OF HEAVY FRAGMENTS IN NUCLEAR DISINTEGRATIONS. O.Skjeggstad and S.O.Sörensen.

Phys. Rev., Vol. 113, No. 4, 1115-24 (Feb. 15, 1959).

A phenomenological description is given of the processes which lead to the emission of energetic heavy fragments from cosmic-ray stars. The energy spectra, angular distribution, and relative frequency of the particles have been determined, and a detailed comparison is made with the predictions from nuclear evaporation theory. A simple method for charge determination of the fragments is described.

6105. POLARIZATION OF NUCLEONS IN INELASTIC SCATTERING FROM NUCLEI. A.K.Kerman, H.McManus and R.M.Thaler.

Phys. Rev. Letters, Vol. 2, No. 4, 172-4 (Feb. 15, 1959).

Using the general form for the scattering matrix in nucleon-nucleus inelastic scattering derived from the impulse approximation a discussion is given of the resulting polarization in terms of the symmetry properties of the nuclear states concerned. Calculations of the polarization at 156 MeV are made for several different cases and, by suitable choice of nuclear parameters, the results are in agreement with experiment. Distortion of the incident nucleon wave due to the nuclear potential is neglected. E.J.Squires

539.17
6106. ON THE ANGULAR DISTRIBUTIONS IN (p, γ) AND (p, γ, γ) REACTIONS. L.Simons.
Comment. phys.-math. (Helsinki), Vol. 23, No. 2, 11 pp. (1959).
Formulae for angular distribution are derived for certain (p, γ) and (p, γ, γ) reactions that occur frequently. Also the 515 and 679 keV resonances in the $\text{Na}^{23}(p, \gamma)\text{Mg}^{24}$ reaction are discussed. For the 515 keV resonance, there are strong reasons for assuming that the compound state (in Mg^{24}) has $J = 2^-$ instead of the generally assumed $J = 1^+$. For the 679 keV resonance, it is confirmed that the compound state has the previously stated $J = 3^+$. The 5.26 MeV Mg^{24} level is assigned the previously assumed spin 3, while the hitherto unknown parity is found to be even. These resonance levels are likely to be formed by jj coupling.

539.17
6107. CROSS SECTIONS FOR ASSOCIATED PRODUCTION BY PROTONS. D.Berley and G.B.Collins.
Phys. Rev., Vol. 112, No. 2, 614-18 (Oct. 15, 1958).

Associated production from different target nuclei was investigated by detecting gamma-rays originating from unstable particles which decay downstream of a target bombarded with 3 BeV protons. The variations in the intensities of these observed gamma-rays with atomic weight of the target nucleus indicate that an appreciable fraction of heavy meson and hyperon production occurs as a result of some two-step process, such as intermediate π -production. For processes which involve production of Σ^0 , Λ^0 , or K^0 by p - p and by p - n collisions, the ratio of the cross-sections for associated production is $\sigma_{pp}/\sigma_{pn} = 0.2 \pm 0.3$.

539.17
6108. STUDY OF SOME (p, n) REACTIONS BY NEUTRON TIME OF FLIGHT. A.J.Elwyn, H.H.Landon, S.Oleksa and G.N.Glasoe.
Phys. Rev., Vol. 112, No. 4, 1200-9 (Nov. 15, 1958).

A millimicrosecond time-of-flight technique was applied to the study of (p, n) reactions in K, Ca^{48} , Ti, Cr, Mn, Fe, Cu, As, and Rb using the phase-focused 3 MeV proton beam from a small fixed-frequency cyclotron. The neutron spectra, resulting from these reactions, gave data from which the ground state Q -values and some of the energy levels in the residual nuclei were determined. The reactions in K and Fe yielded only one neutron group each, which corresponded to the ground states in Ca^{41} and Co^{57} , respectively. In addition to the ground state Q -values, the energies were determined for one excited state in each of the nuclei Mn^{53} , Mn^{54} , and Sr^{85} , two excited states in Zn^{65} , three excited states in Sr^{87} , and four excited states in each of the nuclei Sc^{48} , V^{49} , Fe^{55} , and Se^{75} . The angular distributions of the neutron groups were observed to be essentially isotropic in the $\text{Ca}^{48}(p, n)\text{Sc}^{48}$ and $\text{Cu}^{65}(p, n)\text{Zn}^{65}$ reactions.

539.17
6109. P-N ASYMMETRIES AT 143 MeV. S.G.Carpenter and R.Wilson.
Phys. Rev., Vol. 113, No. 2, 650-3 (Jan. 15, 1959).

The asymmetry of neutrons produced by bombardment of C, Al, Cu, and Pb by 143 MeV polarized protons, at angles 20° to 70° , was measured. The asymmetry is almost independent of target element but is consistent with that from a free p - n collision. The mechanism for the process is discussed.

539.17
6110. POLARIZATION OF SCATTERED PROTONS NEAR 17 MeV. W.A.Blanpied.
Phys. Rev., Vol. 113, No. 4, 1099-104 (Feb. 15, 1959).

Experimental angular distributions of the polarization of protons elastically scattered from magnesium, calcium, copper, silver, and gold near 17 MeV are presented, and comparison with certain theoretical calculations made. Data are also given on the polarization of inelastic protons scattered from magnesium with $Q = -1.37$ MeV. The familiar double-scattering method was used, with carbon serving as second scatterer. It is concluded that appreciable elastic polarization may be universally expected at this energy, and that therefore some form of spin-orbit interaction is important.

539.17
6111. STUDY OF THALLIUM, LEAD, AND BISMUTH NUCLEI PRODUCED IN THE BOMBARDMENT OF GOLD WITH 380 MeV PROTONS. A.E.Metzger and J.M.Miller.
Phys. Rev., Vol. 113, No. 4, 1125-33 (Feb. 15, 1959).

Gold has been bombarded by the 380 MeV proton beam of the Nevis cyclotron in a study of secondary reactions. Secondary reactions produce nuclei with charges greater than that of a target nucleus by means of an intermediate fragment emitted from one target

nucleus and absorbed in a second. The increase in atomic number permits isolation of the effect by chemical separation. Thallium, lead, and bismuth fractions were separated from irradiated gold bars and carefully purified. The radioactive decay of these samples was followed with a $\text{NaI}(\text{Tl})$ crystal scintillation counter. Nuclei produced by secondary reactions were detected for all three elements, the yields decreasing rapidly with increasing atomic number. From the secondary reaction yields of thallium and lead isotopes, it has been possible to calculate the upper portion of the energy distribution of the respective intermediate alpha and lithium fragments. This provides a comprehensive picture of a secondary reaction and demonstrates (1) that the yield of secondary particles is a rapidly increasing function of the bombardment energy for a given target nucleus, (2) that the energy distribution of the secondary fragment possesses an appreciable high-energy tail, and, (3) that secondary reactions can be treated in terms of conventional nuclear reaction theory.

539.17
6112. TIME-REVERSAL INVARIANCE AND PARITY CONSERVATION IN STRONG INTERACTIONS. L.Rosen and J.E.Brolley, Jr.
Phys. Rev. Letters, Vol. 2, No. 3, 98-101 (Feb. 1, 1959).

Three experiments to test these principles are reported. The first compares the inverse reactions $p + t \rightleftharpoons d + d$ at 6.3 MeV centre-of-mass energy in the $p + t$ system; it places an upper limit $\sim 2\%$ on the part of the matrix element odd under time-reversal. The second checks the polarization-asymmetry equality in proton-nucleus scattering at 7 MeV; the equality holds within experimental error. Finally the intensities for scattering 10 MeV polarized protons from nuclei in directions parallel and antiparallel to the polarization vector are compared; this puts an upper limit $\sim 3\%$ on the part of the matrix element which mixes parities.

R.J.N.Phillips

539.17
6113. PRODUCTION OF HELIUM AND ARGON IN IRON TARGETS BY ENERGETIC PROTONS. O.A.Schaeffer and J.Zähringer.
Z. Naturforsch., Vol. 13a, No. 4, 346-7 (April, 1958). In German.

The production cross-section of helium and argon isotopes is measured in iron targets irradiated by 0.16, 0.43 and 3 GeV protons respectively. A comparison with existing data is made of the $\text{He}^4/\text{He}^3/\text{T}$ and $\text{A}^{38}/\text{A}^{36}$ ratios and their relation to the values found in meteoritic iron discussed.

S.J.St-Lorant

539.17 : 539.12
NEUTRON THRESHOLDS OF C^{13} , F^{19} AND Na^{23} FOR PROTON BOMBARDMENT. See Abstr. 6004

539.17 : 539.163.2
REACTION $\text{A}^{40}(p, n)\text{K}^{40}$ AND THE DECAY OF K^{40} . See Abstr. 6076

539.17
6114. NOTE ON THE $^{12}\text{C}(d, p)^{13}\text{C}$ REACTION NEAR THE 4 MeV RESONANCE. J.Dąbrowski and B.Tulczyjew.
Acta phys. Polon., Vol. 16, No. 3, 231-4 (1957).

539.17
6115. EFFECT OF MODE MIXTURES ON n - γ CORRELATIONS FROM STRIPPING REACTIONS. S.Edwards, Jr.
Phys. Rev., Vol. 113, No. 5, 1277-84 (March 1, 1959).

The heavy-particle stripping mode has been included in the Born-approximation stripping theory of n - γ angular correlations for the $\text{B}^{11}(d, n)\text{C}^{12}(\gamma)\text{C}^{12}$ first excited state reaction. Because of the dependence of the relative contributions from the deuteron and heavy-particle stripping modes on neutron angle and the variation of the relative orientation of their preferred axes of quantization with neutron angle, the total correlation function is a function of neutron angle. The correlation functions for each mode depend on the coupling scheme assumed for the angular momenta involved in the reaction.

539.17
6116. PROTON-GAMMA ANGULAR CORRELATION STUDIES OF Be^9 AND $\text{Ca}^{40}(d, p\gamma)$ STRIPPING REACTIONS. R.T.Taylor.
Phys. Rev., Vol. 113, No. 5, 1293-7 (March 1, 1959).

To investigate the applicability of the Butler stripping theory, the angular correlations have been measured between the protons and γ -rays from the reactions $\text{Be}^9(d, p\gamma)\text{Be}^{10*}$ (3.37 MeV) and $\text{Ca}^{40}(d, p\gamma)\text{Ca}^{41*}$ (1.95 MeV), using 7.78 MeV deuterons. Both correlations in the (d, p) plane are of the form $1 + A_2 P_2(\cos \theta)$, where θ is the angle between the γ -ray and the recoil nucleus, as predicted by theory. For Be^9 the coefficient $A_2 = -0.33 \pm 0.04$, in reasonable agreement with the previously reported value of -0.40 ± 0.05 for a

deuteron energy of 4 MeV, and hence confirming the theoretically expected energy independence. This value of A_2 is close to that of -0.40 predicted on the assumption of $L-S$ coupling with the assignment of a $^3P_2$ state for the first excited level of Be^{10} . For Ca^{40} , $A_2 = +0.17 \pm 0.04$, in satisfactory agreement with the predicted value of 0.143 obtained by using the reasonable assumption of $j-j$ coupling with less than 10^{-30} M3 in the predominantly $E2\gamma$ transition. Both transitions showed less than 6% effect in the correlation in the plane perpendicular to the recoil axis, in agreement with the isotropy expected from the simplified stripping theory.

539.17

6117. NEUTRON SPECTRA FROM $Be^9(He^3,n)C^{11}$ AND $Be^9(He^4,n)C^{12}$ USING PULSE SHAPE DISCRIMINATION IN AN ORGANIC SCINTILLATOR.

A.E. Litherland, E. Almqvist, R. Batchelor and H.E. Gove. Phys. Rev. Letters, Vol. 2, No. 3, 104-6 (Feb. 1, 1959).

The ratio of the intensity of the long-period decay component to that of the short-period decay is greater for recoil protons than for electrons, so that by using only the slow component to gate linear pulses from an earlier dynode, which are then pulse-height analysed, it is possible by increasing the discriminator bias applied to the gating pulse, to eliminate γ -ray pulses. High energy neutron groups from the $Be^9(He^3,n)C^{11}$ and $Be^9(\alpha,n)C^{12}$ reactions are clearly shown by steps in the recoil proton spectrum. The neutron-gamma discrimination for a number of liquid scintillators and stilbene is assessed.

A.E.I. Research Laboratory

539.17

6118. TIME-REVERSAL INVARIANCE AND THE INVERSE REACTIONS $C^{12} + \alpha \rightleftharpoons N^{14} + d$.

D. Bodansky, S.F. Eccles, G.W. Farwell, M.E. Rickey and P.C. Robison. Phys. Rev. Letters, Vol. 2, No. 3, 101-4 (Feb. 1, 1959).

Time-reversal invariance is tested by comparing the angular distributions for these inverse (ground state) reactions, using 20.0 MeV deuterons and 41.7 MeV α -particles. This places an upper limit $\sim 3\%$ on the part of the Hamiltonian which is odd under time-reversal.

R.J.N. Phillips

539.17 : 539.14

STUDY OF LEVELS IN O^{18} THROUGH THE RADIATIVE CAPTURE OF ALPHA PARTICLES BY C^{14} . See Abstr. 6061

539.17

6119. EFFECT OF RECOIL ON THE ELASTIC SCATTERING OF HIGH-ENERGY ELECTRONS BY ZERO-SPIN NUCLEI.

L.L. Foldy, K.W. Ford and D.R. Yennie.

Phys. Rev., Vol. 113, No. 4, 1147-53 (Feb. 15, 1959).

The effect of nuclear recoil on the elastic scattering of high-energy electrons or muons by zero-spin nuclei is studied by adapting the Breit two-particle Hamiltonian to the case that one of the two particles is of finite size, is spinless, and is nonrelativistic, the other being a normal point Dirac particle. A radial and angular separation of the Dirac equation is still possible. To leading order in the parameter (electron energy)/(nuclear mass), the effect of the dynamic recoil terms is to rotate the scattering amplitude vectors in the complex plane without changing their magnitudes, a result which is independent of the shape and size of the nuclear charge distribution. To this order, the cross-section is affected only by the kinematic recoil corrections. The dynamic recoil terms also influence the scattering amplitudes through terms of order (electron mass)/(nuclear mass). These corrections, owing to large amplification factors in going from phase shifts to cross-section, may be of some significance in muon scattering, but are probably of no importance in the analysis of high-energy electron scattering. The dynamic effect is proportional to nuclear charge and therefore nearly as great for heavy as for light nuclei.

539.17

6120. THE ELECTRODISINTEGRATION OF NUCLEI AT HIGH ENERGIES. M.Ya. Kobiashvili.

Zh. eksper. teor. Fiz., Vol. 33, No. 6(12), 1505-6(1957).

In Russian.

translation in: Soviet Physics — JETP (New York), Vol. 6(33), No. 6, 1162-3 (June, 1958).

Reports a calculation of the electrodisintegration cross-section, for given energy and momentum of the final electron and ejected neutron. This neutron is regarded as initially bound in a central well, but as a free particle in the final state.

R.J.N. Phillips

6121. INVESTIGATIONS OF (γ, pn) AND (γ, d) REACTIONS WITH GAMMA ENERGIES UP TO 32 MeV. A. Hofmann and P. Stoll. Helv. phys. Acta, Vol. 31, No. 6, 591-600 (1958). In German.

Photon-induced two-particle emission was investigated with a 32 MeV betatron. The yields of the following reactions were determined: $Ca^{40}(\gamma, pn)K^{38}$, $Zn^{64}(\gamma, pn)Cu^{62}$, $Zn^{66}(\gamma, pn)Cu^{64}$, $Se^{80}(\gamma, pn)As^{78}$, $Mo^{92}(\gamma, pn)Nb^{90}$, $Sb^{123}(\gamma, pn)Sn^{121}$. The cross-section v. photon energy relationship was measured for the reactions $Ca^{40}(\gamma, pn)K^{38}$ and $Zn^{66}(\gamma, pn)Cu^{64}$. The integrated cross-section of the $Zn^{66}(\gamma, nn)Zn^{66}$ process is about double that of the $(\gamma, pn) + (\gamma, d)$ reaction on Zn^{66} . ($\sigma_{Zn^{66}(\gamma, pn)} + \sigma_{Zn^{66}(\gamma, d)} = 0.031 \pm 0.008$ MeV barn). The value for the $Zn^{66}(\gamma, nn)$ reaction is calculated from statistical theory to be $\sigma_{Zn^{66}(\gamma, nn)} = 0.088$ MeV barn. The yield of $(\gamma, pn) + (\gamma, d)$ reactions, together with the yield of (γ, α) and (γ, p) reactions were plotted as a function of nuclear charge. It is evident, that the $(\gamma, d + \gamma, pn)$ yields have the same shape as the (γ, p) reactions.

539.17

6122. THE INDUCED ALPHA-ACTIVITY OF GAMMA-EXCITED NUCLEI. P. Erdős, P. Scherrer and P. Stoll.

Helv. phys. Acta, Vol. 30, No. 7, 639-90 (1957). In German.

Photon-induced alpha emission of nuclei was investigated with a 32 MeV betatron. The servo-stabilized energy of the betatron was calibrated by means of the reaction $O^{16}(\gamma, n)O^{15}$. The following new reactions were discovered: $O^{18}(\gamma, \alpha)C^{14}$, $K^{39}(\gamma, \alpha)Cl^{34}$, $Rb^{85}(\gamma, \alpha)Br^{80m}$, $Rb^{87}(\gamma, \alpha)Br^{82}$, $Sb^{121}(\gamma, \alpha)In^{117m}$, $Ta^{181}(\gamma, \alpha)Lu^{177}$, $Tl^{205}(\gamma, \alpha)Au^{201}$ and $Tl^{205}(\gamma, \alpha)Au^{200}$. The yields of 15 (γ, α) -reactions were determined. Special emphasis was laid on heavy nuclei, where the peak of the (γ, α) cross-section does not coincide with the giant resonance of photon absorption. The cross-section v. photon energy was measured for the reactions $Sb^{121}(\gamma, \alpha)In^{117}$, $Tl^{205}(\gamma, \alpha)Au^{201}$, $Tl^{205}(\gamma, \alpha)Au^{200}$. The energy spectrum of alpha particles emitted from Cl and Br was determined by nuclear emulsion techniques. The alpha spectra with a single peak show a low energy tail below the Coulomb barrier height, similar to that observed in cosmic ray spallation stars, thus indicating a lower Coulomb barrier height than calculated using a sharp nuclear boundary at $r = 1.5 \times 10^{-13} A^{1/3}$ cm. The yields of (γ, α) -, (γ, n) - and (γ, p) -reactions were plotted as a function of the nuclear charge. The (γ, p) and (γ, α) yields are fairly constant above $Z = 50$.

539.17

6123. THE $^{35}Cl(\gamma, n)^{34}Cl$ AND $^{35}Cl(\gamma, n)^{34}Cl^m$ REACTIONS INVESTIGATED UP TO 31 MeV.

F. Ferrero, S. Ferroni, R. Malvano, S. Menardi and E. Silva. Nuovo Cimento, Vol. 11, No. 3, 410-14 (Feb. 1, 1959).

Measurements are given of photoneutron cross-sections for activation of the 1.58 s ground state and of the 32 min isomeric state in Cl^{34} . The branching ratio is found to be of the order of unity. A tentative explanation of the peculiar behaviour of the branching ratio in the region of the giant resonance is given.

539.17

6124. PHOTONEUTRON CROSS SECTIONS OF Li^6 AND Li^7 .

T.A. Romanowski and V.H. Voelker.

Phys. Rev., Vol. 113, No. 3, 886-90 (Feb. 1, 1959).

The total photoneutron production cross-sections for Li^6 and Li^7 were determined from the yields measured with a neutron detector. The efficiency of the neutron detector was found from the comparison of the detected and computed neutron yield from copper. In the calculation of the cross-section the inverse photon matrix formulation of the photon difference method was used. The Li^6 cross-section has a peak at about 12.5 MeV and its absolute value at the peak is equal to 2.8 ± 0.53 mb. The Li^7 cross-section has a peak at about 14 MeV and its value at the peak is equal to 3 ± 0.75 mb.

539.17

6125. PHOTONUCLEAR REACTIONS OF GALLIUM AND ARSENIC WITH 70 MeV BREMSSTRAHLUNG.

F.D. Schupp, C.B. Colvin and D.S. Martin, Jr.

Phys. Rev., Vol. 113, No. 4, 1095-8 (Feb. 15, 1959).

Radiochemical techniques were utilized in the measurement of yields of photonuclear reactions induced by 70 MeV bremsstrahlung in gallium and arsenic targets. For As targets the yields of As^{74} , Ga^{73} , Ga^{72} , Ga^{68} , Zn^{69} , and Zn^{69m} were determined. In the gallium targets the yields of Zn^{69} , Zn^{69m} , Ni^{65} , and Co^{61} were measured. The integrated cross-sections for the indicated photonuclear reactions were estimated from the yields. The integrated cross-sections of five $(\gamma, 3p3n)$ processes were compared. The relative yields of the Zn^{69} isomeric pair depended upon the process of formation.

539.17
6126. PHOTOPRODUCTION OF CHARGED π MESONS FROM NUCLEI. J.R.Waters.

Phys. Rev., Vol. 113, No. 4, 1133-40 (Feb. 15, 1959).

The γ -ray beam from the Cornell synchrotron was used to investigate the photoproduction of low-energy charged π mesons from several nuclei at 35° to the beam direction. Maximum photon energies used were 800 MeV and 1 BeV. The yields of 40 and 80 MeV π^+ and 40 MeV π^- mesons were observed with a detection system whose aperture was known absolutely. It was found that in some cases the meson yields were proportional to the atomic number, A, of the target rather than the more usual $A^{2/3}$. The data are compared with the predictions of an optical model of the nucleus. The deviations observed can be partially explained in terms of the inelastic scattering of high-energy mesons and of multiple meson production. An excitation function was measured for 80 MeV π^+ mesons from carbon by varying the machine energy; this indicated the presence of an appreciable number of multiply produced mesons.

539.17
6127. COMPETITIVE PROCESSES IN THE PHOTODISINTEGRATION OF NICKEL. J.H.Carver and W.Turchinetz.

Proc. Phys. Soc., Vol. 73, Pt 4, 585-92 (April, 1959).

Excitation functions were measured for the (γ, n) , (γ, p) and $(\gamma, pn + \gamma, 2n)$ reactions in Ni^{58} and the (γ, p) reaction in Ni^{62} , from threshold to 32 MeV. A preponderance of protons is found from Ni^{58} with the ratio

$$\int_0^{32} \sigma(\gamma, p) dE / \int_0^{32} \sigma(\gamma, n) dE = 2.35 \pm 0.20.$$

The shapes of the (γ, n) and (γ, p) cross-sections are found to be very similar, peaking near 19 MeV with widths of about 4.3 MeV. The $Ni^{58}(\gamma, pn + \gamma, 2n)$ cross-section increases monotonically from threshold to 32 MeV, and the integrated cross-section is about 12% of the total which is

$$\int_0^{32} [\sigma(\gamma, n) + \sigma(\gamma, p) + \sigma(\gamma, pn + \gamma, 2n)] dE = (0.84 \pm 0.10) \text{ MeV barns.}$$

The $Ni^{62}(\gamma, p)$ reaction is found to have an integrated cross-section of (0.13 ± 0.02) MeV barns and to peak at 22 MeV, with a width of about 5.2 MeV.

539.17
6128. CROSS-SECTIONS FOR (γ, p) REACTIONS IN Mn, Cu AND Sb. W.Lohmann.

Z. Naturforsch., Vol. 13a, No. 8, 701-3 (Aug., 1958). In German.

Using γ -rays from the $Li(p, \gamma)$ process and nuclear emulsions as detectors, cross-sections were measured. Using values obtained by other workers for the (γ, n) cross-sections, the ratios $(\gamma, p)/(\gamma, n)$ are obtained. These agree with the statistical theory, although a higher number of energetic protons are found experimentally than predicted.

G.E.Brown

539.17 : 539.14
6129. DETERMINATION OF THE NUCLEAR TEMPERATURE OF MANGANESE AND COPPER FROM THE ENERGY SPECTRA OF PHOTOPROTONS FROM THE REACTIONS $Mn(\gamma, p)$ AND $Cu(\gamma, p)$.

W.Lohmann.

Z. Naturforsch., Vol. 13a, No. 10, 905-6 (Oct., 1958). In German. Temperatures of 1.0 ± 0.1 MeV and 0.87 ± 0.1 MeV are obtained for Mn and Cu, respectively, if all protons are considered to come from compound-nucleus processes.

G.E.Brown

539.17
6130. ANGULAR DISTRIBUTION AND POLARIZATION OF 3.3 MeV NEUTRONS SCATTERED ON Cu, Ta, Pb AND Bi.

A.E.Remund.

Helv. phys. Acta, Vol. 29, No. 5-6, 545-84 (1956). In German.

The differential cross-sections and the azimuthal asymmetries (polarization-effects) for elastic scattering were measured at intervals of 15° from 30° to 150° . The angular distributions of neutrons scattered by neighbouring elements with appreciably different atomic weight show marked differences. The experimental results are compared with theoretical cross-sections calculated using the complex square-well potential of Feshbach, Porter and Weisskopf (Abstr. 5081/1953, 524/1955). The differential polarization as a function of angle is calculated with an additional spin-orbit coupling term

$$V = -\{V_0 + i \cdot W + V' \cdot \vec{\sigma} \cdot \vec{l}\}.$$

Left-right scattering asymmetries were measured for the same 4 elements, ranging in atomic weight from copper to bismuth. From

these asymmetries the magnitudes of the polarization were determined. The variation of polarization with atomic number appears similar to the calculated values.

539.17
6131. CHARGED PARTICLES EMITTED FROM ALUMINIUM ON BOMBARDMENT WITH 14 MeV NEUTRONS.

P.V.March and W.T.Morton.

Phil. Mag. (Eighth Ser.) Vol. 3, 1256-61 (Nov., 1958).

The energy spectra of the charged particles were measured for the angular intervals $16-48^\circ$ and $132-164^\circ$. Groups of protons corresponding to known levels in Mg^{27} were found. The ratio of the differential cross-section for the forward angular interval to that for the corresponding backward interval was found to be 2.6.

539.17
6132. COMPOUND-NUCLEUS PROCESSES FOR THE REACTION $U^{235} + n$. E.R.Rae, B.Margolis and E.S.Troubetzkoy.

Phys. Rev., Vol. 112, No. 2, 492-7 (Oct. 15, 1958).

The neutron capture and inelastic scattering cross-sections of U^{235} are calculated on the basis of the statistical theory of nuclear reactions in the energy region up to 1.1 MeV. Experimental data are used from the resonance region, including the radiation width and the level spacing of the compound nucleus. One also makes use of the measured fission and total cross-sections in the energy range considered, the spectrum of excited states of the target, and an exponential level-density law for the compound states. The agreement with experiment is good.

539.17
6133. ENERGY DISTRIBUTION OF NEUTRONS SCATTERED BY LIQUID LEAD. I.Pelah, W.L.Whittemore and A.W.McReynolds.

Phys. Rev., Vol. 113, No. 3, 767-8 (Feb. 1, 1959).

An experiment was performed to test some of the predictions of a recent theory of neutron scattering by liquids proposed by Vineyard (Abstr. 5205/1958). Neutrons of 0.0685 eV were scattered at 90° degrees by lead at 250° , 330° , and $550^\circ C$, and the widths at half maximum of the energy distributions were determined. The width at $250^\circ C$ for solid lead was obtained for comparison purposes and found to be slightly narrower than would be predicted for a perfect gas model. The results for liquid lead show (1) that the simple diffusion model gives a slightly broader distribution than is observed for neutrons scattered by lead near the melting point and (2) that this model predicts a much larger variation of the width with temperature than is observed experimentally.

539.17
6134. EFFECTS OF CHEMICAL BINDING ON THE NEUTRON CROSS SECTION OF HYDROGEN.

W.L.Whittemore and A.W.McReynolds.

Phys. Rev., Vol. 113, No. 3, 806-8 (Feb. 1, 1959).

Fermi derived the energy dependence of the neutron scattering cross-section of hydrogen chemically bound such that it acts as a harmonic oscillator. For comparison with this theory, the total cross-section was measured with a high-resolution crystal spectrometer for hydrogen bound in four materials. In zirconium and yttrium hydrides, in which chemical bonding is relatively isotropic, the predicted structure with discrete energy levels is observed. In the less isotropic magnesium hydride, there is some evidence of energy levels, although not clearly resolved. For water the variation in the cross-section is smooth, with no evidence of energy levels.

539.17
6135. $C^{12}(n, p)B^{12}$ CROSS SECTION FOR 14.9 TO 17.5 MeV NEUTRONS. W.E.Kreger and B.D.Kern.

Phys. Rev., Vol. 113, No. 3, 890-4 (Feb. 1, 1959).

The cross-section for the $C^{12}(n, p)B^{12}$ reaction was measured for 14.9 to 17.5 MeV neutrons. The neutrons were obtained from the $T(d, n)He^4$ reaction and their flux density was determined by counting the recoil alpha particles or by counting the neutrons directly with a $Li^6I(Eu)$ scintillation counter. A cylindrical plastic scintillator 5 in. in diameter and 3 in. in length served as the carbon-containing target and permitted the counting of the B^{12} decay beta-rays in nine consecutive 7 msec intervals during the "beam off" period of a pulsed neutron beam cycle. The cross-section rises from slightly above the reaction threshold of 13.6 MeV to a value of 29.09 ± 4.36 millibarns at 17.5 MeV. The B^{12} beta-decay half-life was redetermined as 18.87 ± 0.50 msec.

539.17
6136. SCATTERING OF NEUTRONS BY NONSPHERICAL NUCLEI. H.M.Schey.
Phys. Rev., Vol. 113, No. 3, 900-3 (Feb. 1, 1959).
A discrepancy between experiment and the optical model calculations of Bjorklund and Fernbach (Abstr. 8978/1958) exists in the scattering of 7 MeV neutrons by tantalum. The possibility is investigated that this discrepancy is due to the quadrupole deformation in tantalum. The deformation is represented by a term proportional to $P_2(\cos\gamma)$ added to the spin-dependent potential of Bjorklund and Fernbach (γ is the angle between the assumed nuclear symmetry axis and the radius vector to the scattered particle). The added term is treated as a perturbation and the calculation is carried to second order. The Schrödinger equation is solved numerically on an IBM-704 computer to obtain the differential cross-section for the elastic scattering of neutrons and the results are applied to the scattering of 7 MeV neutrons by tantalum. Parameters are determined which bring the theoretical results into adequate agreement with experiment.

539.17
6137. NONELASTIC SCATTERING CROSS SECTION FOR 8-20 MeV NEUTRONS. T.W.Bonner and J.C.Slatery.
Phys. Rev., Vol. 113, No. 4, 1088-90 (Feb. 15, 1959).
Measurements of the nonelastic scattering cross-section for neutrons with energies of 8.2, 9.8, 15.5, 17.0, 18.5 and 20.0 MeV have been made in Cu, Ag, Sn, Pb, and Bi. Cross-sections were determined from transmissions through spherical shells. Neutrons of 8.2 and 9.8 MeV were obtained from the reaction $\text{Be}^9(\alpha, n)\text{C}^{12}$ and the higher energy neutrons from the reaction $\text{T}^3(d, n)\text{He}^4$. Biased scintillation detectors were used so that lower energy neutrons were not counted. The results show that the nonelastic cross-sections decrease slowly with increasing neutron energy, in contrast to the cross-sections for elastic scattering which show broad maxima at 7, 13, 13, 18, and 18 MeV, respectively, for Cu, Ag, Sn, Pb, and Bi. The ratio of the nonelastic cross-section to the elastic cross-section vary from a maximum value of 1.05 ± 0.05 to a minimum value of 0.71 ± 0.05 in the energy range which was covered.

539.17
6138. NEUTRON CROSS-SECTION MEASUREMENTS AT 4.5 BeV. J.H.Atkinson, W.N.Hess, V.Perez-Mendez and R.W.Wallace.
Phys. Rev. Letters, Vol. 2, No. 4, 168-9 (Feb. 15, 1959).
Using a neutron beam of $\sim 4.5^{+1.5}_{-1.0}$ GeV, measurements were made of σ_{total} and σ_{reaction} for carbon, copper and lead. Monitoring of the incident neutron beam was carried out, using a counter telescope, placed in the collimator, which detected charged pions produced in a lead filter. Transmitted neutrons were detected by the charged pions produced in a 12 in. Be convertor and recorded by a counter telescope consisting of two scintillators and a Cherenkov counter with energy threshold set to 3 GeV. A description of the steps taken to avoid spurious counts is given. Measurements were made both in good and poor geometry, and show that $\sigma_{\text{absorption}}$ remains essentially constant from 300 MeV upwards, but that σ_{total} (elastic) is markedly reduced. Results are compared, in the case of lead, with opaque-nucleus calculations, good agreement being obtained.
A.E.I. Research Laboratory

539.17
6139. GENERALIZED DIFFRACTION THEORY FOR VERY-HIGH-ENERGY COLLISIONS. A.E.Glassgold and K.R.Greider.
Phys. Rev. Letters, Vol. 2, No. 4, 169-71 (Feb. 15, 1959).
A simple model is used to describe the scattering of neutrons from 0.3 to 4.5 BeV off nuclei. In this model, the opacity is assumed to have a constant value for small values of l and to decrease to zero in a region of width 2Δ , centred about a value L . The phase is assumed constant. It is assumed that $L \propto kA^{1/3}$ and that $\Delta \propto k$, where k is the momentum. It is possible to fit the total and reaction cross-sections of C, Cu and Pb at the above energies by taking suitable values of the parameters. The scattering amplitude turns out to be almost purely imaginary.
E.J.Squires

539.17
6140. ACTIVATION CROSS-SECTIONS OF Mn^{55} , Cu^{63} , Pd^{108} and In^{115} FOR THERMAL NEUTRONS. H.Meister.
Z. Naturforsch., Vol. 13a, No. 10, 820-2 (Oct., 1958). In German.
A 500 mC Ra + Be source of neutrons was used. Results are compared with those of Hughes and Harvey (Hughes and Harvey, Neutron Cross Sections, Brookhaven National Laboratory, 1955), and others.
G.E.Brown

539.17
6141. RELATIVE CROSS-SECTIONS OF THE (n,p) AND (n,α) REACTIONS ON ELEMENTS WITH SEVERAL STABLE ISOTOPES. V.N.Levkovskii.
Zh. eksper. teor. Fiz., Vol. 33, No. 6(12), 1520-1 (1957). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 6(33), No. 6, 1174-5 (June, 1958).
An attempt is made to establish an empirical law for the reactions as a function of the fundamental characteristics of the nucleus. A regular decrease in the (n,p) cross-sections is observed and it is concluded that a relationship may exist between the probability of proton emission from an excited nucleus and the relative nucleon concentration in the nucleus.
S.J.St-Lorant

539.17 : 539.14
6142. NEUTRON EMISSION FOLLOWING μ -MESON CAPTURE IN SILVER AND LEAD. S.N.Kaplan, B.J.Moyer and R.V.Pyle.
Phys. Rev., Vol. 112, No. 3, 968-78 (Nov. 1, 1958).
The neutron yield from the capture of cosmic-ray μ^- mesons in silver and lead was measured by use of a high-efficiency Cd-loaded liquid-scintillator tank. The average multiplicities were determined to be $\bar{\nu}_{\text{Ag}} = 1.60 \pm 0.18$ and $\bar{\nu}_{\text{Pb}} = 1.64 \pm 0.16$. The multiplicity distributions were also measured and compared with several theoretical models. Although an α -particle model gave results not inconsistent with the data, a Fermi-gas model with the effective nucleon mass M^* set equal to $M/2$ seemed to provide the better fit.

539.17
6143. REMARKS ON NUCLEAR SCATTERING OF K^+ -MESONS. N.N.Biswas, M.Ceccarelli and N.Schmitz.
Z. Naturforsch., Vol. 12a, No. 9, 693-8 (Sept., 1957). In German.
A review of the results obtained up to the present time on the K^+ -proton scattering and on nuclear inelastic scattering in nuclear emulsions. A Fermi gas model has been used to account for the behaviour of the scattered particles: the reflection at the nuclear surface and the absorption, as well as multiple collisions with nucleons in the nucleus are also considered. An independent particle model gives good agreement with experimental results at high energies, but cannot be used satisfactorily at low energies.
G.Martelli

539.17 : 539.12
CAPTURE OF NEGATIVE K-MESONS IN COMPLEX NUCLEI.
See Abstr. 6046

539.17
6144. STUDY OF NUCLEAR EVAPORATION IN Ag AND Pt BY MEANS OF EMULSION SANDWICHES. C.Zangger and J.Rossel.
Helv. phys. Acta, Vol. 29, No. 5-6, 507-32 (1956). In French.
The technique of sandwiching metals foils of different elements between nuclear emulsions is analysed in its application to the study of nuclear evaporation induced by cosmic rays in Ag and Pt at 3600 m above sea level. The characteristics of the star-size distributions and of the nuclear evaporation in the two elements are investigated with special emphasis on the anomalies in the energy spectrum of the emitted α -particles. Theoretical interpretations are discussed.

539.17
NUCLEAR REACTIONS DUE TO COSMIC RAYS. See also the Section entitled "COSMIC RAYS".

539.17
6145. NEUTRON SPECTRA FROM MOCK-FISSION SOURCES. E.Tochilin and R.V.Alves.
Nucleonics, Vol. 16, No. 11, 145, 146, 148 (Nov., 1958).
The compositions and neutron yields of three mixes of Po with B, F, Be, and Li are tabulated. The neutron spectrum from one of these sources was measured using photoplates and the spectra of the other two calculated by comparison. A closer approximation to a fission spectrum in the 5 to 10 MeV region could be obtained by increasing the Be content 10 times.
R.D.Smith

539.17
6146. HALOGEN DELAYED-NEUTRON ACTIVITIES. G.J.Perlow and A.F.Stehney.
Phys. Rev., Vol. 113, No. 5, 1269-76 (March 1, 1959).
A gas-flow technique has been developed to make rapid chemical separations of bromine and of iodine fission products from a solution of U^{235} irradiated with thermal neutrons. The active bromine or iodine is observed by its delayed neutron emission. Analysis of the

decay curves so obtained has been made by graphical and by computer methods. Four delayed-neutron periods have been found in the bromine fraction and three in the iodine. Including several already well known, the half-lives and probable mass assignments are as follows: 54.5 sec Br^{87} , 16.3 sec Br^{88} , 4.4 sec Br^{86} , and 1.6 sec Br^{90} ; 24.4 sec I^{137} , 6.3 sec I^{138} , and 2.0 sec I^{139} . Shorter-lived halogens would not have been detected. The relative yields of each neutron activity in the order of decreasing half-life are, for bromine, 0.37 : 1.0 : 1.9 : 1.5; while for iodine they are 1.0 : 0.47 : 0.38 in the same order. If it is assumed that there are no other important contributors of delayed neutrons in this half-life range, the numerical values of yields for bromine may be compared directly with those for iodine with an uncertainty of a factor of 2.

539.17

6147. DETERMINATION OF THE ABSOLUTE NEUTRON FISSION CROSS SECTION OF U^{235} . G.J.Safford and E.Melkonian. Phys. Rev., Vol. 113, No. 5, 1285-93 (March 1, 1959).

The absolute cross-section at 0.0253 eV has been determined by measuring (σ_f/σ_t) at 5.3 A and combining this with scattering, absorption, and relative fission cross-section measurements. Two multiplate ionization chambers, one containing B^{10} and the other U^{235} , were constructed. The flux is determined by making the two chambers as alike as possible and comparing counting rates in the same neutron beam. The amounts of U^{235} and B^{10} in the beam are determined by transmission measurements. After corrections for chamber efficiencies, residual differences between chambers, and incoherent scattering, a value for $(1 + \alpha) = 1.171 \pm 0.009$ at 5.3 A was obtained. This leads to a value of 580 ± 7 barns as the absolute fission cross-section at 0.0253 eV. These results are independent of the absolute neutron cross-section of B^{10} .

539.17

6148. MULTIPLICATION OF FAST NEUTRONS IN THICK FUEL ELEMENTS. K.O.Thielheim.

Atomkernenergie, Vol. 4, No. 3, 89-93 (March, 1959). In German.

Multiplication in elements of plane or spherical geometry is discussed and a simple formula for the fast fission factor ϵ given. If the fuel element is only slightly subcritical, $\epsilon \gg 1$. The diffusion part and the transport correction of ϵ are considered. The diffusion part can be found by means of a boundary condition giving the value of the diffusion flux near the source. For small fuel dimensions, the results from this method are compared with those from the variational method.

539.17

6149. POSSIBILITY OF SMOOTHING [ABFLACHUNG] NEUTRON FLUXES BY MEANS OF HETEROGENEOUSLY DISTRIBUTED ABSORBERS (BREEDER MATERIAL) AT THE CORE OF CYLINDRICAL THERMAL REACTORS. W.Kattwinkel.

Atomkernenergie, Vol. 4, No. 3, 93-8 (March, 1959). In German.

The effect is calculated (using one group theory) of several arrangements — linear and proportional to $J_0(\mu r)$ — of additional absorbers (breeder materials) on the space-dependence of the thermal neutron flux in cylindrical reactors with jacket reflectors. Flattening of the neutron flux is achieved, together with a higher mean power density in the core.

539.17 : 518.6

6150. AN ANALOGUE DEVICE FOR DETERMINATION OF BUCKLING. T.Kohonen and O.Ivanto.

Ann. Acad. Sci. Fennicae A VI, No. 14, 13 pp. (1958).

Starting from the one-group approximation of a bare thermal reactor, an analogue device was designed, by means of which the geometric buckling of a cylindrical reactor of an arbitrary cross-section can be determined. The system consists essentially of a vibrating membrane, the resonance frequency of which is measured. The boundary conditions at the control rods, which are assumed to be completely black to thermal neutrons, are simulated by equivalent fixed areas of the membrane. The model seems to be suitable for calculations of control rod effectiveness, especially for complicated cross-sections. An accuracy of 1% is achievable.

539.17

6151. P_3 -APPROXIMATION FOR THE CALCULATION OF THERMAL UTILIZATION [OF A REACTOR]. H.Engel.

Atomkernenergie, Vol. 3, No. 4, 129-33 (April, 1958). In German.

The calculation of the thermal utilization by ordinary diffusion theory is a somewhat rough approximation. Absorption and anisotropic scattering of neutrons should be taken into account by a better method. In the special case of plane geometry and isotropic scattering in the laboratory system an analytic expression can be found for the thermal utilization by a P_3 -approximation. Comparison between the P_3 -approximation and diffusion theory shows, however, that the accuracy of the latter is sufficient.

6152. THE ROLE OF CRITICAL FACILITIES.

I. CRITICAL FACILITIES FOR REACTOR DESIGN. W.C.Redman.

II. CRITICAL FACILITIES FOR BASIC PHYSICS. H.C.Paxton. Nucleonics, Vol. 16, No. 12, 40-1, 42 (Dec., 1958).

Critical facilities are used for (1) reactor design, (2) weapons design, (3) determination of criticality limits in processing operations, and (4) basic physics data. The most important use is for reactor design. In many cases the construction of a critical system gives more detailed and more accurate data at a lower cost than the alternative approach of multigroup neutron calculations on a digital computer. A flexible zero-power assembly can be used to find the basic characteristics of a range of systems of differing geometries and compositions. When the design has been settled more detailed measurements can be made in an accurate simulation of the actual reactor. Critical facilities can also be used for estimating the changes in reactor properties resulting from fuel burn-up, changes in core loading, or the insertion of experimental assemblies into the reactor core (e.g. ETRC). Measurements can be made of critical size, reflector savings, reactivity coefficients, control rod effectiveness, the distributions of flux, fission rates and capture rates, and most other neutron physical properties of the reactor. Those facilities designed primarily for basic physics data measurements usually have very simple geometry and can be used for checking computational methods and determining reactor calculation parameters.

R.D.Smith

539.17

6153. HIGH-TEMPERATURE CRITICAL FACILITY.

J.A.Bistline and C.S.Hofmann.

Nucleonics, Vol. 16, No. 12, 46-7 (Dec., 1958).

The Proof Test Reactor (PTR) enables measurements to be made on light water moderated U^{235} fuelled systems at temperatures and pressures up to 650° F and 1500 psi. The core is $8 \times 32 \times 30$ cm and the 93% U^{235} fuel strips are clad in zircalloy.

R.D.Smith

539.17 : 536.24

RECENT INVESTIGATION ON HEAT TRANSFER IN WATER.

A CONTRIBUTION TO THE PROBLEM OF WATER-COOLED REACTORS. See Abstr. 5613

539.17 : 523.51

HELIUM AND NEON AS REACTION PRODUCTS OF HIGH ENERGY PARTICLES IN IRON METEORITES. See Abstr. 5315

ATOMS

539.18

6154. NEW TECHNIQUES IN THE LAMB SHIFT CALCULATION.

H.M.Fried and D.R.Yennie.

Phys. Rev., Vol. 112, No. 4, 1391-404 (Nov. 15, 1958).

Based on the analogy between the calculations of radiative corrections to electron scattering and the Lamb shift, a new procedure applicable to bound state self-energy problems is developed, wherein the electron propagator is expanded in powers of the external potential. In the resulting sequence, a change in the gauge of the virtual photon field conveniently removes from each term spurious lower order contributions and yields a new and considerably simpler sequence; the expectation value of the first two terms of the latter is shown to account for the major portion of the Bethe logarithm. A simple method is developed to sum all the $\alpha(Z\alpha)^4\mu$ dependence, and the result is the lowest order Lamb shift formula. The ease of the calculation, as well as that involved in obtaining the relativistic level shift correction of order $\alpha(Z\alpha)^5\mu$ (not given in the present paper), indicates that the method may find application in the calculation of further higher order effects.

539.18

6155. NEW CALCULATION OF THE NUMERICAL VALUE OF THE LAMB SHIFT. C.Schwartz and J.J.Tiemann.

Ann. Phys. (New York), Vol. 6, No. 2, 178-87 (Feb., 1959).

Calculation of the second-order perturbation in hydrogen which gives the low-energy part of the Lamb shift. A formula is derived for $\ln(k_0)$ involving a double integral. The final numerical evaluation of this formula (using a series expansion) yield what is believed to be the most accurate value of $\ln(k_0)$ yet given. Small discrepancies with the earlier results of Harriman are outside the realm of current physical significance, but do indicate that the

reliability of the earlier results was badly overestimated. Approximate formulae for the radiative-perturbed wave functions are given; these may be quite useful for further calculations.

539.18

6156. NUCLEAR MAGNETIC SHIELDING CONSTANTS FOR SEVERAL 2-, 3-, AND 4-ELECTRON ATOMS AND IONS.

F.T.Ormand and F.A.Matsen.

J. chem. Phys., Vol. 30, No. 2, 368-71 (Feb., 1959).

Nuclear magnetic shielding constants have been calculated for H^- , He, Li^+ , Be^{++} , Li, Be^+ , and Be using both open- and closed-configuration wave-functions with optimized orbital exponents. The accuracy of the values reported is supported by the close agreement between the values obtained for He, $\sigma = 5.9856 \times 10^{-6}$ and $\sigma = 5.9913 \times 10^{-6}$, respectively, and that obtained by Hylleraas and Skavlem using the first five terms of the Hylleraas wave-function, $\sigma = 5.9938 \times 10^{-6}$.

539.18

6157. ON THE TRANSFER OF EXCITATION ENERGY IN RARE GAS MIXTURES THROUGH COLLISIONS OF THE SECOND KIND.

W.Friedl and S.Hagen.

Optik, Vol. 15, No. 11, 686-93 (Nov., 1958). In German.

In Kr/Hg mixtures, excited Kr atoms can, by collision, excite Hg atoms to several slightly lower levels; the intensities of some mercury lines are thus increased with increasing Kr pressures; and curves of intensity against pressure are given. Similar effects are found with He/Ne mixtures, but not with Ar/Xe, although the energy levels are suitable.

G.F.Lothian

539.18

6158. EFFECT ON THE ENERGY OF INCREASED FLEXIBILITY IN THE SEPARABLE FACTOR OF HYLLEAAS-TYPE ATOMIC WAVE FUNCTIONS FROM H^- TO O VII. L.C.Green, S.Matsushima, C.Stephens, E.K.Kolchin, M.M.Kohler, Y.Wang, B.B.Baldwin and R.J.Wisner.

Phys. Rev., Vol. 112, No. 4, 1187-91 (Nov. 15, 1958).

A number of wave-functions of the form $f(r_1)f(r_2)g(r_{12}, r_{13}, r_{23})$ are applied to the two-electron systems from H^- to O VII. Various analytic expressions for f and g are employed. The values of the various parameters in f and g are chosen to yield the minimum energy. The wave-functions, the values of the parameters, and the minimum energies are tabulated. Twenty of the twenty-six functions tabulated are presented here for the first time. For five of the remaining six functions the values of the parameters and the energies have been recomputed. The energies obtained with these wave-functions as well as with functions investigated by others are examined to ascertain what improvement in the energy results from considering other functional forms for $f(r)$ than the customary negative exponential. In the case of H^- , it is clear that certain types of flexibility in $f(r)$ can substantially improve the energies obtained with the simpler functions. For larger nuclear charge the improvement is definite but smaller. The functions obtained are of interest in themselves. Several of them give the lowest energies for H^- so far found for various specific numbers of parameters. Beyond Li II, no simple wave-functions involving the interelectron distance were previously available.

539.18

6159. ANALYTIC WAVE FUNCTIONS. II. ATOMS WITH 1s, 2s, 2p, 3s, AND 3p ELECTRONS. R.G.Breene, Jr.

Phys. Rev., Vol. 113, No. 3, 809-13 (Feb. 1, 1959).

For Pt I, see Abstr. 1798 (1959). The variation programme for the computation of atomic wave functions which was developed and programmed for the IBM-704 electronic data processing machine is detailed. This calculation was set up so as to be able to handle atoms having any combination of 1s, 2s, 2p, 3s, and 3p electrons. One example of the programme is provided by a calculation of the wave functions for aluminium for all degrees of ionization. Another example is provided by a calculation of the fourteen configurations for oxygen having the electron distribution $(1s)^2(2s)^2(2p)^3(3p)$. Finally, the three ^3P wave functions thus obtained are combined by means of the configuration interaction.

539.18

6160. EFFECT OF AN ELECTRIC DIPOLE MOMENT OF THE PROTON ON THE ENERGY LEVELS OF THE HYDROGEN ATOM.

R.M.Sternheimer.

Phys. Rev., Vol. 113, No. 3, 828-34 (Feb. 1, 1959).

The perturbations of the energy levels of the hydrogen atom by a possible electric dipole moment of the proton, d , were obtained. The inhomogeneous equation for the first-order perturbation of the

wave functions was solved analytically. The shifts of the energy levels are of the second order in d . In particular, there results a decrease of the Lamb shift between the $2S_{1/2}$ and $2P_{1/2}$ levels. By equating this decrease to the maximum allowed by the approximate agreement between the experimental and theoretical values of the Lamb shift, it is concluded that the electric dipole moment of the proton, d , must be less than 1.3×10^{-13} cm times the charge of the electron. Calculations have also been carried out for the shifts of the energy levels of deuterium produced by a possible electric dipole moment of the deuteron.

539.18

6161. EXCITED STATE WAVE FUNCTIONS, EXCITATION ENERGIES, AND OSCILLATOR STRENGTHS FOR Ne($2p^53s$).

A.Gold and R.S.Knox.

Phys. Rev., Vol. 113, No. 3, 834-9 (Feb. 1, 1959).

Solutions of the Hartree-Fock equations for the ^3P and ^1P terms of neon ($2p^53s$) were obtained. Wave functions are tabulated and results of computations of excitation energies and oscillator strengths are presented. The former fall within 10% of experimental values. It is found that enlarging the size of the "invariant core" used to compute the excited state wave functions has only a small effect on the predicted energies. The predicted oscillator strength of the 736 Å transition is 0.11, which is in reasonable agreement with available experimental data considering the large uncertainties in the measurements. The computed diamagnetic susceptibility of the ground state is -7.4×10^{-6} cm³ mole, in good agreement with experiment.

539.18 : 537.568

6162. ELECTRON RECOMBINATION IN ATOMIC HYDROGEN.

R.G.Fowler and W.R.Atkinson.

Phys. Rev., Vol. 113, No. 5, 1268-9 (March 1, 1959).

The absolute intensity of radiation of the continuum associated with the Balmer lines has been measured in a region of zero electric field by observing the expanding plasma in a shock tube. It is shown that the corresponding continuum energy can be explained by assuming that it is composed of the recombination and affinity spectrum of atomic hydrogen at a certain electron temperature. Values of the electron recombination coefficients can be derived which agree with those calculated by Cillie and disagree with those obtained from other measurements.

539.18

6163. THE EXCITATION MECHANISM IN IMPACTS OF FAST ELECTRONS WITH XENON. W.Friedl and K.Schmidt.

Z. Naturforsch., Vol. 13a, No. 2, 79-83 (Feb., 1958). In German.

Refers to previous work by the same author on gas scintillation counters etc. The xenon energy level diagram is used in a discussion of fast electron collisions with xenon atoms. It is concluded that, in addition to direct excitation, stepwise excitation from metastable states is also important.

J.D.Craggs

539.18

6164. ELECTRON AFFINITIES OF THE LIGHTER ELEMENTS.

Y.P.Varshni and S.N.Srivastava.

Z. phys. Chem. (Leipzig), Vol. 206, No. 3-4, 221-30 (Feb., 1957).

Describes an unsuccessful attempt to improve the extrapolation formula $I = a + bZ + cZ^2$, which gives the ionization potential of an ion in terms of those in an isoelectronic sequence, by adding either a term in Z^3 or a term in $1/Z$. Predicted values for electron affinity for all elements up to $Z = 18$ are given, but show no material improvement over the simple formula.

J.Hawgood

539.18 : 535.332

TERM ANALYSIS OF THE SECOND SPECTRUM OF RHENIUM.

See Abstr. 5500

539.18

6165. ATOMIC MASSES OF THE STABLE ISOTOPES OF LEAD AND MERCURY AND THE MASS DIFFERENCE D_2-He^4 .

J.L.Benson, R.A.Damerow and R.R.Ries.

Phys. Rev., Vol. 113, No. 4, 1105-7 (Feb. 15, 1959).

Mass doublets have been measured from which atomic masses for the stable isotopes of mercury and lead are found. The doublet D_2-He^4 has also been measured and found to have a value 25.6074 ± 3 mMU.

539.18

6166. HAEFFNER EFFECT IN Sn, Cd AND Zn. A.Lodding.

Z. Naturforsch., Vol. 12a, No. 7, 569-73 (1957). In German.

Previous investigations of the isotope effect in a number of molten metal capillaries is extended to include Sn, Cd and Zn. The

measured "mass coefficient" for Sn increased by a factor of 2 between 285°C and 590°C but for Cd it remained constant between 370°C and 540°C. Further measurements are necessary before a complete understanding of the transfer processes in molten metals is achieved. G.C.Williams

539.18 : 541.135.2

6167. THE TEMPERATURE DEPENDENCE OF THE ISOTOPE EFFECT FOR THE ELECTROLYTIC MIGRATION OF CHLORINE IONS IN MOLTEN THALLIUM (1) CHLORIDE.

W.Herzog and A.Klemm.

Z. Naturforsch., Vol. 13a, No. 1, 7-16 (Jan., 1958). In German.

The mass effect (i.e. the relative difference in the migration velocities/relative difference of the masses) for the electrolytic migration of chlorine ions in molten TlCl was measured in the temperature range 565°C ≤ t ≤ 730°C and a linear relation obtained:

$$\mu = -0.077\{1 - 0.00192(t - 565)\}$$

The mechanism of this temperature dependence is discussed. In a 26 day experiment with the series Tl (anode)/TlCl/Tl (cath.) Cl³⁵ was enriched from its normal concentration of 75.4% to 98.4% in the best sample, giving a separation factor of 20. H.C.Cole

539.18

6168. THE USE OF METHYL CHLORIDE FOR THE MASS SPECTROMETRIC ISOTOPIC ANALYSIS OF CHLORINE.

W.Herzog and E.Dörnenburg.

Z. Naturforsch., Vol. 13a, No. 1, 51-2 (Jan., 1958). In German.

Methyl chloride is found to be particularly suitable for the isotopic analysis of chlorine in a gaseous substance, and does not exhibit the ageing effects which occur with chlorine from ionic sources; moreover, the test samples can be reduced to one-fifth the size employed with the latter. Details for the preparation of ammonium chloride from silver chloride and thence of methyl chloride are included. There are 12 references. H.H.Hodgson

539.18

6169. A METHOD OF RAPID ELECTROMAGNETIC SEPARATION OF RADIOACTIVE ISOTOPES. J.Uhler and T.Alvåger.

Ark. Fys., Vol. 14, Paper 29, 473-80 (1958).

A method has been developed for rapid, electromagnetic separation of microgram quantities of solid substances containing activities. A new ion source equipped with two furnaces has been built. One of the furnaces, containing some milligram of carrier, gives the vapour pressure required for the discharge. The other furnace, which contains the active sample, can be connected to the discharge chamber during separation and be heated rapidly up to 1000°C. Separation of Pb²¹² has given 5% over all efficiency after 7 min separation.

539.18 : 539.12

6170. THE SEPARATION OF AN ATOMIC BEAM INTO COMPONENTS WITH ORIENTED ELECTRON-SHELL SPINS, USING AN EXPONENTIAL MAGNETIC FIELD. A.D.Timofeev and Ya.M.Fogel'. Zh. tekhn. Fiz., Vol. 27, No. 9, 2129-33 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 9, 1974-8 (Sept., 1957).

Presents calculations of particle trajectories and other design factors which show that it should be possible to obtain much more intense beams of polarized protons by this method than by that suggested by Rabi. J.Hawgood

539.18

6171. COLLISIONS OF METASTABLE ATOMS. J.B.Hasted. J. appl. Phys., Vol. 30, No. 1, 22-4 (Jan., 1959).

Collision experiments with He 2³S and Ne 3²P metastable atoms are described, giving the total collision cross-sections of these atoms with He, Ne, A at thermal energies, also the absorption cross-sections of resonance photons from the He, Ne discharges. The secondary electron yields from He metastable atoms and from resonance photons incident upon W, Mo, Pt surfaces flashed to 1700°C are compared with the yields from an unflashed Au surface, previously determined absolutely. The rate of rise of yield due to gas contamination is examined. The yields from the flashed surfaces are found to be distinctly smaller than Hagstrum's (1956) yields for low-energy positive ions.

539.18

6172. COLLISIONS OF ELECTRONS WITH HYDROGEN ATOMS. I. IONIZATION. W.L.Fite and R.T.Brackmann.

Phys. Rev., Vol. 112, No. 4, 1141-51 (Nov. 15, 1958).

The cross-section for ionization of the hydrogen atom on electron impact has been measured as a function of electron energy.

A modulated beam of atoms and molecules in varying proportions, taken from a furnace, is crossed by a d.c. electron beam, and the positive ions formed are taken into a mass spectrometer. By using such modulation techniques, the ions formed by ionization of the beam are distinguished from the much larger number of ions formed by collisions of electrons with the residual gas in the vacuum chamber. From the study of the mass-spectrometer peak strengths as a function of temperature with constant gas flow, the ratio of the cross-sections for ionization of the atom and the molecule is directly determined. The absolute atomic cross-sections, determined by multiplying this ratio by the known molecular cross-sections, are cross-checked by taking relative cross-sections for the atom. Complete agreement with the first Born approximation is found only above about 250 eV. Deviations of experiment from theory at lower energies are as predicted qualitatively by theory.

539.18

6173. COLLISIONS OF ELECTRONS WITH HYDROGEN ATOMS. II. EXCITATION OF LYMAN-ALPHA RADIATION.

W.L.Fite and R.T.Brackmann.

Phys. Rev., Vol. 112, No. 4, 1151-61 (Nov. 15, 1958).

The excitation cross-section was measured as a function of electron energy. The measurement is made by observing Lyman-alpha photons with an iodine-vapour-filled photon counter. A relative-cross-section curve is normalized to fit the Born approximation for high electron energies. The experiment utilizes a 100 c/s modulated atomic beam whose purity in hydrogen-atom content is determined by ionization and mass analysis. A d.c. electron beam crosses the modulated ground-state atomic beam. The photon counter, which looks at the interaction region, has its output passed through a tuned amplifier and phase-sensitive detection system. Although this treatment of the counter output as an a.c. current (in which the quantum of charge is that of a Geiger-Müller pulse) introduces some unique noise problems, it satisfactorily separates the photons which arise from the interaction under study from those which arise from other processes (e.g. electron collisions with the residual gas in the high-vacuum chamber). Some implications of the measured excitation cross-section upon scattering theory are discussed.

539.18

6174. COLLISIONS OF ELECTRONS WITH HYDROGEN ATOMS. III. ELASTIC SCATTERING.

R.T.Brackmann, W.L.Fite and R.H.Neynaber.

Phys. Rev., Vol. 112, No. 4, 1157-61 (Nov. 15, 1958).

The cross-section for elastic scattering of electrons of less than 10 eV energy by free hydrogen atoms has been measured. The experimental approach was similar to that used by Bederson, Malamud, and Hammer (1957), in that a d.c. electron beam crossed an atomic hydrogen beam, which was chopped at a low frequency, and the signal was derived from the electrons scattered by the particles in the neutral beam. The electrons scattered by the beam were identified by their signal's appearing at the modulation frequency and at a specified phase. Direct measurements of the ratio of cross-sections of the hydrogen atom and the molecule were made, and absolute values for the atomic cross-section were obtained from knowledge of the absolute molecular cross-section. The experimental results agree with theory.

539.18

6175. INELASTIC ION-ATOM COLLISIONS. J.B.Hasted. J. appl. Phys., Vol. 30, No. 1, 25-7 (Jan., 1959).

Ion-atom charge exchange cross-sections of incident ion velocity v in the adiabatic region are shown to be proportional to exp(-K'a|ΔE|/v) energy defect ΔE. Maximum cross-sections of the negative ion-atom detachment collision and certain other inelastic ion-atom collisions are shown to be proportional to the maximum kinetic energy available for internal excitation, $\frac{1}{2}\mu v^2$, where μ is the reduced mass of the system. The semiempirical prediction of cross-section energy dependence is discussed.

539.18

6176. INTERACTIONS BETWEEN GROUND-STATE NITROGEN ATOMS AND MOLECULES. THE N-N, N-N₂, AND N₂-N₂ INTERACTIONS. J.T.Vanderslice, E.A.Mason and E.R.Lippincott. J. chem. Phys., Vol. 30, No. 1, 129-36 (Jan., 1959).

Potential energy curves for N-N interactions corresponding to the X¹Σ_g⁺, A¹Σ_u⁺, ³Σ_g⁺, ³Σ_u⁺, B³Π_g, C³Π_u, and a¹Π_g states of N₂ were calculated, as well as curves for the N-N₂ and N₂-N₂ interactions. All calculations were based as nearly as possible on experimental data, including spectroscopically determined vibrational

energy levels, scattering cross-sections of atomic beams in gases, and measured vibrational relaxation times. In cases where experimental data were not available, approximate quantum-mechanical calculations were made. Results obtained by these various methods are remarkably consistent with one another, and are believed to have good accuracy.

539.18 : 539.19

6177. NUCLEAR MAGNETIC SHIELDING AT LARGE DISTANCES OF A HYDROGEN ATOM IN AN ELECTRIC FIELD. H.F.Hameka. *Nuovo Cimento*, Vol. 11, No. 3, 395-400 (Feb. 1, 1959).

The nuclear magnetic shielding constant of a hydrogen atom in a uniform electric field is calculated at a point P which is situated at a large distance from the nucleus in the direction of the electric field. The main term of the screening constant is found to be proportional to the first power of the electric field and to the inverse second power of the distance between P and the hydrogen nucleus.

MOLECULES

539.19

6178. A CASE FOR EFFICACY OF HULBURT-HIRSCHFELDER POTENTIAL FUNCTION. N.R.Tawde and M.R.Katti. *Indian J. Phys.*, Vol. 33, No. 1, 18-22 (Jan., 1959).

The Hulburt-Hirschfelder potential energy function is tested for its efficacy in relation to Morse's expression. Its five-parameter character is converted to four-parameter one, with a view to deriving the fifth parameter α_e . The calculated data are then compared to the accurately known experimental data of a large number of diatomic molecules. The expression proves superior to Morse's and even to some others known to be better than Morse's.

539.19

6179. CORRELATION CORRECTION STUDY OF CH, NH, AND OH. M.Krauss and J.F.Weher. *J. chem. Phys.*, Vol. 29, No. 6, 1287-97 (Dec., 1958).

The semiempirical intra-atomic correlation correction (ICC) of Hurley and a configuration-interaction (CI) calculation are applied to previous single configuration calculations of the ground states of CH, NH, and OH. Results are reported for the $^2\Pi$, $^4\Sigma^-$, and $^2\Delta$ states of CH, the $^3\Sigma^-$ state of NH, and the $^2\Pi$ state of OH. The binding energies and dipole moments obtained for the hydrides are compared with experimental values and with the results of a similar calculation by Hurley of the ground states of these molecules. Results of a calculation of the Fermi contact term of the magnetic hyperfine interaction are also given.

539.19

6180. GROUND STATE OF HYDROGEN BY THE RYDBERG-KLEIN-REES METHOD.

J.T.Vanderslice, E.A.Mason, W.G.Maisch and E.R.Lippincott. *J. molecular Spectrosc.*, Vol. 3, No. 1, 17-29 (Feb., 1959).

A detailed investigation is made of the Rees modification (Abstr. 380/1948) of the Rydberg-Klein graphical method of calculating potential energy curves without the use of empirical functions (such as Morse functions). The $X^1\Sigma_g$ ground state of H_2 is chosen for investigation because of the large amount of both experimental and theoretical information available. It is found that the Rees procedure yields an accurate potential curve very rapidly, and hence the use of empirical functions is questionable when data are available and accurate curves are desired. The present calculations for H_2 join smoothly with the accurate quantum mechanical calculations of Dalgarno and Lynn, valid at large internuclear separations. The resulting "most likely" potential energy curve agrees between 0.5 Å and 2.0 Å with a similar curve given previously by Hirschfelder and Linnett, but at smaller and larger distances differs appreciably from the Hirschfelder-Linnett curve.

539.19

6181. ON THE "METHOD OF ATOMS IN MOLECULES". H.Preuss.

Z. Naturforsch., Vol. 12a, No. 8, 599-603 (1957). In German.

It is shown that the two approximate theories of molecular wave-functions associated with the names of Moffitt (Abstr. 2866/1952) and Bingel (Abstr. 375/1958) can be combined with considerable advantage. For example for the ground state of H_3^+ the combined theory gives 1.95 eV for the binding energy and 2.3 atomic units for the nuclear separation. [c.f. corresponding numbers 1.75, 2.6 (Moffitt)

and 2.78, 2.0 (exact); the Bingel theory does not lead to a bound state]. The Moffitt theory is best at large nuclear distance, the Bingel theory at small distances and the combined theory proposed here provides a kind of interpolation.

R.O.Davies

539.19

6182. FACTORIZATION AND WAVE FUNCTIONS FOR THE SYMMETRIC RIGID ROTATOR. D.G.Burkhard.

J. molecular Spectrosc., Vol. 2, No. 3, 187-202 (June, 1958).

Solutions to the wave-equation for the symmetric rigid rotator are obtained by the factorization method. The shift operators yield directly the matrix elements of the cartesian body fixed and space fixed components of the angular momentum operators. Recurrence relations and matrix elements for the sine and cosine of the azimuthal angle θ are also derived.

539.19

6183. SIMPLIFIED METHODS FOR THE COMPUTATION OF ASYMMETRIC ROTOR ENERGY LEVELS AND LINE STRENGTHS. E.K.Gora.

J. molecular Spectrosc., Vol. 2, No. 3, 259-72 (June, 1959).

The form of the reduced energy matrices used by previous authors as starting point for computations has been modified by a simple algebraic reduction in a manner which permits substantial savings in the amount of numerical work required for the calculation of rigid rotor energy levels and centrifugal distortion corrections. A simplification of the line strength calculations is achieved by using a method for the determination of the diagonalization matrices needed in these calculations which is more straightforward than the method described by King, Hainer, and Cross (1943). Explicit line strength formulae for low rotational quantum numbers and approximation formulae for nearly symmetric rotors are given.

539.19

6184. A NORMAL COORDINATE ANALYSIS OF THE PLANE XY_6 MOLECULE. C.W.F.T.Pistorius.

J. molecular Spectrosc., Vol. 2, No. 3, 287-96 (June, 1958).

The secular equations for the various irreducible representations of the plane XY_6 molecule (point group D_{6h}) were deduced by means of Wilson's F-G matrix method, using the most general harmonic potential field. The equations for the case of SVFF are also given.

539.19

6185. A NOTE ON THE CALCULATION OF ROTATIONAL DISTORTION CONSTANTS FOR AXIALLY SYMMETRIC ZX_3Y MOLECULES. J.M.Dowling, R.Gold and A.G.Meister.

J. molecular Spectrosc., Vol. 2, No. 4, 411-12 (Aug., 1958).

A previous paper [*J. molecular Spectrosc.*, Vol. 1, 265 (1957)] is extended to include molecules in which the interbond angles are not tetrahedral.

539.19 : 551.521.326

6186. CONDITIONS OF EXCITATION AND INTENSITY DISTRIBUTION IN THE INFRARED OH BANDS. F.Kraus.

Z. Naturforsch., Vol. 12a, No. 6, 479-89 (1957). In German.

A laboratory study of the various conditions of excitation of the OH rotational-vibrational bands observed in the infrared night-sky glow. The only favourable result was obtained when the excitation was due to the reaction $O_3 + H = O_2 + OH$; the distribution of intensity of the individual bands, observed in this case, corresponded with that of the night-sky glow. The rotation temperature calculated from the experimentally obtained intensity distribution of rotation lines was 700°K, compared with 200°K for night sky.

F.Lachman

539.19 : 551.521.326

6187. THE TEMPERATURE OF THE OH-RADICAL IN DIFFERENT LIGHT SOURCES. G.Joos and H.Ringler.

Z. Naturforsch., Vol. 13a, No. 5, 428 (May, 1958). In German.

The value for the rotation temperature of the OH-radical in the oxyacetylene flame was found to be $3300 \pm 300^\circ\text{K}$, and is in good agreement with that deduced by Lurie and Sherman (Abstr. 3099/1933) from line reversals. The corresponding value for night-sky illumination is 200°K (Abstr. 7121, 9160/1950), whereas in the ozone-hydrogen reaction-zone it is $710 \pm 30^\circ\text{K}$ (Kraus, preceding abstract).

H.H.Hodgson

539.19

6188. VIBRONICALLY INDUCED ABSORPTION OF FORBIDDEN INFRARED TRANSITIONS. W.R.Thorson.

J. chem. Phys., Vol. 29, No. 4, 938-44 (Oct., 1958).

The usual selection rules governing the appearance of infrared

fundamental frequencies in absorption are found to break down in the case when the molecule is in a degenerate electronic state capable of other vibronic interactions such as the Jahn-Teller effect. The intensity of such forbidden transitions is discussed and the conclusion reached that absorption is too weak to be observed except in such cases that the Jahn-Teller effect has produced sufficient distortion to destroy the symmetry of the original configuration and remove the electronic degeneracy; and under such conditions the previously "forbidden" transitions always become allowed by normal considerations for the nondegenerate electronic state of the molecule in the distorted configuration.

- 539.19
6189. INTERACTION OF THE VIBRATIONAL AND ELECTRONIC MOTIONS IN SOME SIMPLE CONJUGATED HYDROCARBONS. I. EXACT CALCULATION OF THE INTENSITY OF THE ${}^1A_g \rightarrow {}^1B_{1u}, {}^1B_{2u}$ VIBRONIC TRANSITIONS OF BENZENE. A.D.Liehr. Z. Naturforsch., Vol. 13a, No. 4, 311-35 (April, 1958).

The finite intensities of the forbidden bands at 50 000 and 39 500 cm^{-1} is due to the interaction of rotational, vibrational and electronic motions. The effect of the latter two is calculated, a form of perturbation theory suitable for computation being developed. Calculated oscillator strengths are 0.26 and 0.003 (experimental values are 0.1 and 0.002). The error in the first value is due to incipient breakdown of the perturbation formulae. There are large errors in the relative intensities of the vibrational components of the bands.

G.F.Lothian

- 539.19
6190. ELECTRON CORRELATION IN MOLECULES. I. THE ETHYLENE MOLECULE. W.Kołos. Acta phys. Polon., Vol. 16, No. 4, 257-66 (1957).

The excitation energies of the ethylene molecule were calculated using in the interaction integrals of the π -electrons wavefunctions, depending explicitly on the mutual electron separation. The resulting energies are in satisfactory agreement with experimental values.

- 539.19
6191. ELECTRON CORRELATION IN MOLECULES. II. THE BENZENE MOLECULE. W.Kołos. Acta phys. Polon., Vol. 16, No. 4, 267-78 (1957).

The energy levels of benzene were calculated by an extended molecular orbital method. In the interaction integrals, between electrons having opposite spins and belonging to the same pair, wavefunctions depending explicitly on the mutual electron separation were used. An assignment of the ${}^1B_{1u} \leftarrow {}^1A_g$ transition for the experimental band at 6.2 eV is suggested.

- 539.19
6192. ELECTRONIC STRUCTURE OF LiH . IV. HYDROGEN ATOM POLARIZATION. O.Platas and F.A.Matsen. J. chem. Phys., Vol. 29, No. 4, 965-6 (Oct., 1958).
For Pt III, see Abstr. 736 (1959). Inclusion of configurations with 2p orbitals centred on the H atom has little effect on the calculated energy but an appreciable effect on the dipole moment.

J.Hawgood

- 539.19
6193. LIGAND FIELD THEORY OF Ni(II) COMPLEXES. III. ELECTRONIC SPECTRA AND SOLUTION PARAMAGNETISM OF SOME DIAMAGNETIC Ni(II) COMPLEXES. G.Maki. J. chem. Phys., Vol. 29, No. 5, 1129-38 (Nov., 1958).

For earlier work, see Abstr. 734-5 (1959). The observed electronic absorption spectra of six diamagnetic Ni chelates were successfully assigned using ligand field theory with consistent values of the field parameters. The observed solution paramagnetism of some of these diamagnetic chelates is attributed to an equilibrium between solvated molecules of the same symmetry in singlet and triplet states rather than to a change in symmetry of the complex as has previously been postulated. Calculations of the energies of six-coordinated Ni(II) complexes indicate that solution favours a triplet ground state for each symmetry studied. With this model, the extent of solvent-ion interaction determines the separation of singlet and triplet states and hence the distribution of molecules among these states. The proposed equilibrium mechanism and the calculated energy levels of the ion, used together in a consistent manner, give a quantitative explanation of both the paramagnetism and spectra of these complexes in solution.

- 539.19
6194. SOME NOTES ON THE ELECTRON REPELLING PROPERTY OF ALKYL GROUPS. S.Basu.

J. chem. Phys., Vol. 30, No. 1, 314-15 (Jan., 1959).

Electron donation by alkyl groups and bond angle change due to steric requirement have been found to affect the physicochemical properties of simple saturated molecules in an exactly similar manner.

- 539.19
6195. A QUANTUM-MECHANICAL CALCULATION ON THE SODIUM MOLECULE. D.W.Davies. Trans Faraday Soc., Vol. 54, Pt 10, 1429-40 (Oct., 1958).

A calculation on the ${}^1\Sigma_g^+$ and ${}^1\Sigma_u^+$ states of the sodium molecule is described. The work is an extension of a calculation by R-sen and Ikehara (Abstr. 1341/1933) on the energy of the ground state. They used three approximations, two of which are not followed in this work. As in their work, only the 3s electrons are considered, and a valency bond function is used, but the 3s orbitals are modified to make the s orbital on one atom orthogonal to the 2p σ orbital on the other atom, and calculations are made both with the interaction operator, following Rosen and Ikehara, and with the total Hamiltonian. The energy of the ground state is found to depend critically on the approximations, and modification of Rosen and Ikehara's method leads to much poorer results for the binding energy of the ground state. The excellence of their results is attributed to the cancellation of the sagging error with those introduced by the use of the interaction operator and an inexact wave function. For the excited state, however, use of their method does not give good results, and at the experimental internuclear distance the energy is found to be lower than that of the ground state. No improvement in the excited state energies is obtained in an "atoms-in-molecules" calculation, which for this reason, was not carried out completely. The oscillator strength for the ${}^1\Sigma_g^+ \rightarrow {}^1\Sigma_u^+$ transition is given, calculated both from the dipole length and the dipole velocity. Better values are obtained with the modified orbitals than with the Slater orbitals. All the integrals arising in this work were evaluated exactly, and tables are given in an appendix.

- 539.19
6196. NUCLEAR REORIENTATION SPECTRUM OF Li^7 IN THE GASEOUS MONOMERS AND DIMERS OF THE LITHIUM HALIDES. P.Kusch. J. chem. Phys., Vol. 30, No. 1, 52-7 (Jan., 1959).

The nuclear reorientation spectrum of Li^7 was observed in all of the lithium halides under conditions in which the degree of dimerization of the molecules is first low and then high. In each of the halides the two spectra have a qualitatively different appearance which can only be interpreted under the assumption that at least two different molecular species occur in the beam. An approximate resolution of the spectra into that of the monomer and that of the dimer may be made. Significant differences in both the internal magnetic and the electric quadrupole interactions occur for the monomer and the dimer.

- 539.19
6197. NEGATIVE NUCLEAR SPIN-SPIN COUPLING CONSTANTS FOR AROMATIC PROTONS. H.M.McConnell. J. chem. Phys., Vol. 30, No. 1, 126-8 (Jan., 1959).

Valence bond theory and observed hyperfine splitting data were used to calculate proton-proton spin-spin couplings that arise through long range correlation of π -electron spins in even alternate aromatic hydrocarbons. In benzene and naphthalene calculated spin coupling constants are positive for protons separated by an odd number of carbon-carbon bonds and are negative for protons separated by an even number of carbon-carbon bonds.

- 539.19
6198. SOME CALCULATIONS ON THE PROTON MAGNETIC RESONANCE SHIFT DUE TO HYDROGEN BONDING OF AMMONIA MOLECULES. H.F.Hameka. Nuovo Cimento, Vol. 11, No. 3, 382-94 (Feb. 1, 1959).

The effect of hydrogen bonding on the proton magnetic shielding constants in the ammonia molecule is calculated from gauge invariant atomic orbitals. Following Schneider, Bernstein and Pople, the effect is regarded as made up of two contributions: (a) the inter-molecular shift, which is caused by the induced electronic currents in the adjacent molecule, and (b) the polarization shift, which is caused by the polarization of the N-H bond due to

the electrostatic field of the adjacent molecule. The computed inter-molecular shift is -1.02×10^{-6} , the computed polarization shift is -0.45×10^{-6} . The experimental value of the total effect is -1.05×10^{-6} .

539.19 : 539.18

NUCLEAR MAGNETIC SHIELDING AT LARGE DISTANCES OF A HYDROGEN ATOM IN AN ELECTRIC FIELD. See Abstr. 6177

539.19 : 538.69 : 538.27

DETERMINING MOLECULAR STRUCTURE BY NUCLEAR MAGNETIC RESONANCE OF HYDROGEN. See Abstr. 5941

539.19

6199. STUDY OF HYDROGEN BONDING IN SYSTEMS OF HYDROXYLIC COMPOUNDS IN CARBON TETRACHLORIDE THROUGH THE USE OF NMR. M.Saunders and J.B.Hyne. J. chem. Phys., Vol. 29, No. 6, 1319-23 (Dec., 1958).

The hydroxyl NMR frequencies for *t*-butanol, phenol, and methanol were measured as functions of concentration in carbon tetrachloride solution. The curves obtained were found to fit well to theoretical curves calculated for monomer-trimer equilibrium for *t*-butanol and phenol with $K_3 = 5.60 \text{ l}^2/\text{M}^2$ and $4.78 \text{ l}^2/\text{M}^2$, respectively, and a monomer-tetramer curve with $K_4 = 28.4 \text{ l}^3/\text{M}^3$ for methanol. The data of Becker et al. on the ethanol-carbon tetrachloride system have been fitted to theoretical curves for monomer-trimer $K_3 = 5.19 \text{ l}^2/\text{M}^2$ and monomer-tetramer $K_4 = 44.9 \text{ l}^3/\text{M}^3$.

539.19

6200. VALENCE-BOND INTERPRETATION OF ELECTRON-COUPLED NUCLEAR SPIN INTERACTIONS; APPLICATIONS TO METHANE. M.Karplus and D.H.Anderson. J. chem. Phys., Vol. 30, No. 1, 6-10 (Jan., 1959).

A valence-bond theory, based on the approximate second-order perturbation method of Ramsey, was developed for the calculation of the electron-coupled nuclear spin interactions in a $^1\Sigma$ molecule. It was found possible to derive a general formula which expresses the proton-proton coupling constant in terms of functions that are easily evaluated with the Rumer-Pauling diagrams. The theory is such that, for non-bonded protons, the coupling constant is a sensitive direct measure of deviations from perfect pairing. Application of the theory to methane leads to a numerical value for the coupling constant in agreement with the experimental result. This agreement indicates that contributions of nonperfect-pairing structures to the ground-state wave-function of methane are so small that they can have little effect on the energy.

539.19

6201. CONTACT ELECTRON-SPIN COUPLING OF NUCLEAR MAGNETIC MOMENTS. M.Karplus. J. chem. Phys., Vol. 30, No. 1, 11-15 (Jan., 1959).

The valence-bond theory for the contact electron-spin coupling of nuclear magnetic moments (see preceding abstract) is used to calculate the proton-proton, proton-fluorine, and fluorine-fluorine coupling constants in ethane and ethylenic molecules. A considerable simplification is introduced into the theory by approximations which reduce the problem to one involving only a small number of electrons and canonical structures. The agreement between calculated and experimental values is such as to demonstrate that the mechanism considered is the one of primary importance for the nuclear coupling in the compounds studied. Of particular interest is the theoretical confirmation of the observation that in ethylenic compounds the trans coupling between nuclei (HH, HF, FF) is considerably larger than cis coupling.

539.19

6202. SEMI-EMPIRICAL TREATMENT OF THE HYDROGEN BOND. C.Reid. J. chem. Phys., Vol. 30, No. 1, 182-90 (Jan., 1959).

A semiempirical treatment of the hydrogen bond based on a slightly modified Lippincott-Schroeder potential was used to construct potential surfaces for simultaneous hydrogen and oxygen motion in OH...O hydrogen bonds. The resulting potential curves were used to interpret the changes in infrared spectra and in lattice dimensions in H-bonded crystals on deuteration. The ferroelectricity of KH_2PO_4 is also discussed.

539.19

6203. EMPIRICAL EXPRESSION FOR IONIC CHARACTER AND THE DETERMINATION OF *s* HYBRIDIZATION FROM NUCLEAR QUADRUPOLE COUPLING CONSTANTS. J.K.Wilmschurst. J. chem. Phys., Vol. 30, No. 2, 561-5 (Feb., 1959).

An empirical expression between the amount of ionic character

in a bond and the electronegativities of the atoms is suggested. By using the ionic characters determined from this expression, the halogen nuclear quadrupole coupling constants have been interpreted to determine the percentage *s* hybridization of the halogen bonding orbital. The results indicate that the amount of *s* hybridization increases with the *s* hybridization of the bonding atom and with the increasing electronegativity difference of the two atoms in the bond. A qualitative explanation of these results is discussed.

539.19 : 535.343

6204. POTENTIAL BARRIER FOR PROTON TRANSFER IN HYDROGEN BOND. Y.Sato. Sci. of Light (Tokyo), Vol. 6, No. 2, 69-76 (Aug., 1957).

In infrared studies on the hydrogen bond between phenol and some proton acceptors, two new absorption bands were found in the longer wavelength side of the second overtone band of monomolecular phenol O-H stretching vibration. By assuming a double minimum potential (Abstr. 8311/1956), these two bands are explained as due to association. By the analogy between the separation of these two bands and the line splittings of the inversion doublets in ammonia, the height of the potential barrier is deduced to be about 20 kcal/mole.

539.19

6205. REFORMULATION OF THE JAHN-TELLER THEOREM. W.L.Clinton and B.Rice. J. chem. Phys., Vol. 30, No. 2, 542-6 (Feb., 1959).

The Jahn-Teller theorem is reformulated on the basis of the Hellmann-Feynman theorem. Examples are given illustrating the conceptual simplicity of the force approach as opposed to the energetics approach. Methods of calculation are outlined and an estimation of the effect is given for the borane (BH_3) molecule.

539.19

6206. DIPOLE MOMENT OF THE DIATOMIC MOLECULE. C.Schlier. Z. Phys., Vol. 154, No. 4, 460-73 (1959). In German.

The Stark effect of a rotating anharmonic oscillator is calculated, including terms of up to 10^{-7} relative accuracy, for comparison with recent high precision experiments. A series expansion is used for the internuclear potential and the instantaneous dipole moment as a function of the nuclear distance. The measurable effects are: (1) the change of the dipole moment with the vibrational quantum number *v* up to terms proportional to $(v + \frac{1}{2})^2$; (2) the "isotope shift" of the dipole moment; and (3) some polarizability terms. These are compared with measured values, and are in good agreement with them. A method is sketched to overcome the limitation to fields $\mu E \ll B_e$, which is required for a part of the calculations.

539.19

6207. POLARITY DIFFERENCES BETWEEN DEUTERATED AND NORMAL MOLECULES. E.A.Halevi. Trans Faraday Soc., Vol. 54, Pt 10, 1441-6 (Oct., 1958).

Bell and Coop's method (Abstr. 4647/1938) of calculating differences in the dipole moments of isotopic diatomic hydrides is extended to polyatomic molecules, ammonia being taken as a test molecule.

539.19

6208. THE PLANAR CHARACTER OF ORGANIC COMPOUNDS. H.Preuss. Z. Naturforsch., Vol. 12a, No. 8, 603-8 (1957). In German.

The dependence of the torsion energy on the angle of twist of π -electron systems relative to one another is assessed for the open carbon chain, for triphenylmethyl, and for diphenylmethyl. For the open carbon chain a cosine dependence results from the (Hückel) approximation method used. The connection between resonance energy and torsion angle is more complicated in the radicals. It shows that a twist of the phenyl group by 40° vis-a-vis the π -function of the central carbon atom decreases their resonance energies by about 30%.

W.Good

539.19

6209. ONE-DIMENSIONAL INELASTIC COLLISIONS WITH IMPULSIVE INTERACTIONS. B.Widom. J. chem. Phys., Vol. 30, No. 1, 238-45 (Jan., 1959).

A linear oscillator interacting impulsively with a free particle incident along its line of oscillation will in general suffer a change in state; and this model may be taken to represent an inelastic molecular collision. It is pointed out that this picture is substantially equivalent to that used by Castellan and Hulburt, with one modification. The problem is formulated for both quantum and classical mechanics. Explicit transition probabilities are calculated for two extreme cases: (i) the mass and momentum of the incident particle are small, while its energy is fixed; (ii) the mass of the

incident particle is small and its energy is large, while its momentum is fixed. The quantum form of approximation (i) is essentially the approximate theory of Castellan and Hulburt. In the present paper the emphasis is on approximation (ii), for which it is shown that in both the classical and quantum theories the average energy transferred to an oscillator of mass m by an incident particle of momentum p is $2p^2/m$, whatever the law of force of the oscillator and whatever its initial state. It is also shown in this approximation that the classical transition probability for the harmonic oscillator may be recast in a pseudoquantum form so as to allow direct comparison with the quantum mechanical transition probability over the whole range of momenta of the incident particle.

539.19

6210. SHORT-RANGE INTERACTION BETWEEN A HYDROGEN MOLECULE AND A HYDROGEN ATOM.

H.Aroeste and W.J.Jameson, Jr.

J. chem. Phys., Vol. 30, No. 2, 372-4 (Feb., 1959).

Computations of the interaction at close distances between a hydrogen atom and a hydrogen molecule in their ground states were made using various modifications of atomic orbital methods for the purpose of decreasing the difference between experimental and theoretical results. A choice of states corresponding to the lower root of the second-order secular equation for such distances appreciably reduces the prior theoretical values. Application of the LCAO method decreases the discrepancy to about 6-8 eV and gives reasonably good qualitative agreement with the experimental values. Although computations for a test case indicate no further improvement when the screening constant is varied, a discussion is presented to clarify the calculation of interaction potentials for this procedure. Results for relaxation in the hydrogen molecule inter-nuclear distance are also given.

539.19

6211. ZERO-POINT ENERGY: A CONTRIBUTION TO INTER-MOLECULAR FORCES. E.Whalley.

Trans Faraday Soc., Vol. 54, Pt 11, 1613-21 (Nov., 1958).

When two molecules collide the frequencies of the intramolecular vibrations change and hence the zero-point energy of the system changes. This change of zero-point energy is manifested as an effect on the energies of interaction. Because the effect occurs at all collisions it cannot be distinguished, by measuring the macroscopic effects of collisions, from the usual contributions to the intermolecular forces, and so it must be considered as contributing to intermolecular forces. It is a secondary contribution because it occurs as a direct result of the primary forces, and would not occur in their absence. The energy of interaction of molecules in a bound state is affected by the effect just described, and also by the zero-point energy of the intermolecular vibrations. The magnitude of these effects is discussed, in so far as present knowledge allows, for the hydrogen-bonded substances water, hydrogen fluoride, formic acid, and acetic acid. The effects in non-hydrogen-bonded substances are quite small. The results are summarized in table 2 of the paper. Both inter- and intramolecular zero-point energies can contribute to an important degree to energies of interaction. Because of the zero-point energies care is needed in defining lattice energies, and a definition is proposed.

539.19

6212. MOLECULAR COMPOSITION OF ALKALI FLUORIDE VAPORS. M.Eisenstadt, G.M.Rothberg and P.Kusch.

J. chem. Phys., Vol. 29, No. 4, 797-804 (Oct., 1958).

The abundances of polymeric species of the alkali fluorides in the vapour phase and their dissociation energies were determined by use of the method of Miller and Kusch. For LiF, NaF, KF, RbF, and CsF, the dissociation energies of the dimer are 58.9, 54.3, 47.6, 42.0 and 37.8 kcal/M, respectively. For LiF the trimer was also observed, with a dissociation energy of 38.3 kcal/M. When the salt is in equilibrium with its vapour at a temperature where the vapour pressure is 10^{-8} mm of Hg, the abundance of the dimer decreases in the sequence from LiF to CsF. The heats of sublimation for the various species were also found.

539.19

6213. ENTROPIES AND ENERGIES OF DIMERIZATION OF ALKALI METAL HALIDES. S.H.Bauer, R.M.Diner and R.F.Porter.

J. chem. Phys., Vol. 29, No. 5, 991-5 (Nov., 1958).

Calculated entropies of dimerization for a number of gaseous alkali metal halides, assuming the rhombic planar model for the dimer, fall in the range -31.0 ± 1.5 entropy units. Entropies of dimerization deduced from experimental data for several species disagree appreciably from the calculated values. The differences can

be attributed to uncertainties in the graphical determination of dimerization energies. Energies of dimerization recalculated by combining experimental values of ΔF^0 (dimerization) with theoretical values of ΔS^0 (dimerization) correlate well with the interionic separations in the dimers.

539.19

6214. MASS SPECTROMETRIC STUDY OF THE VAPORIZATION OF LiF, NaF, AND LiF-NaF MIXTURES.

R.F.Porter and R.C.Schoonmaker.

J. chem. Phys., Vol. 29, No. 5, 1070-4 (Nov., 1958).

Vapours effusing from Knudsen cells containing LiF, NaF, and LiF-NaF mixtures were analysed mass-spectrometrically. The over-all temperature range studied was between 900 and 1150°K. Monomers, dimers, and trimers of LiF and NaF were observed. The LiF system has the higher concentration of dimers and trimers. In the LiF-NaF system at 50 mole % LiF the mixed dimer, LiNaF_2 , is the major polymeric vapour species. Thermochemical data for LiF(g) , NaF(g) , $\text{Li}_2\text{F}_2\text{(g)}$, $\text{Na}_2\text{F}_2\text{(g)}$ and $\text{Li}_3\text{F}_3\text{(g)}$ have been obtained. For the reaction $\text{Li}_2\text{F}_2\text{(g)} + \text{Na}_2\text{F}_2\text{(g)} = 2\text{LiNaF}_2\text{(g)}$, ΔH^0 is approximately zero.

539.19

6215. HEATS OF DIMERIZATION OF ALKALI FLUORIDE MOLECULES. R.C.Schoonmaker and R.F.Porter.

J. chem. Phys., Vol. 30, No. 1, 283-5 (Jan., 1959).

See also preceding abstract. A mass spectrometer was used to analyse vapours in equilibrium with alkali fluoride condensed phases. Monomers, dimers, and trimers were detected in all alkali fluoride vapours. In addition to monomers and dimers characteristic of pure condensed phases, mixed dimers were found in equilibrium with mixed condensed phases. A method for determining the difference in dimerization energies for constituents in a mixed vapour was formulated, and dimerization enthalpies for alkali fluoride species are presented.

539.19

6216. MASS SPECTROMETRIC STUDY OF INTER-GROUP IVB MOLECULES.

J.Drowart, G.De Maria, A.J.H.Boerboom and M.G.Inghram.

J. chem. Phys., Vol. 30, No. 1, 308-31 (Jan., 1959).

The systems germanium-graphite and germanium-silicon-carbon were studied. Several gaseous molecules containing Ge, Si, and/or C were observed and their dissociation energies determined from measured partial pressures. A general picture of the dissociation energies of di-, tri- and tetra-atomic intergroup IVB molecules is deduced from these measurements. Incidental to this study the vapour pressure of pure Si was determined; the result confirms the heat of sublimation obtained previously.

539.19

6217. DISSOCIATION ENERGIES OF SOME GASEOUS ALKALI HALIDE COMPLEX IONS AND THE HYDRATED ION $\text{K}(\text{H}_2\text{O})^+$. W.A.Chupka.

J. chem. Phys., Vol. 30, No. 2, 458-65 (Feb., 1959).

A mass spectrometer was used to analyse the ionic species present in the vapours of several alkali halides which were heated in a small oven to temperatures in the range 700-950°K. For the four compounds investigated, NaCl, KCl, KBr, and RbCl, the most abundant ionic species were of the type M^+ and M_2X^+ in comparable amounts. Smaller amounts of M_2X_2^+ ions and, in certain circumstances, negative ions of the type X^- and MX_2^- were also detected. The equilibrium constant was measured as a function of temperature for the reaction $\text{M}_2\text{X(g)}^+ \rightarrow \text{M(g)}^+ + \text{MX(g)}$. Values of the ΔH of this reaction were determined by two independent methods which gave good agreement for all compounds except RbCl. The values of $\Delta H(0^\circ\text{K})$ so determined were 42.3, 41.3, and 41.0 kcal/mole for NaCl, KCl, and KBr, respectively. The more reliable value for RbCl was about 40 kcal/mole which agrees well with a theoretically calculated value of about 42 kcal/mole. An attempt to detect the $\text{K}(\text{H}_2\text{O})^+$ ion in equilibrium with water vapour and KCl at about 840°K was apparently successful, although positive identification of the ion could not be made. The equilibrium constant for the reaction $\text{K}(\text{H}_2\text{O(g)})^+ \rightarrow \text{K(g)}^+ + \text{H}_2\text{O(g)}$ was measured and gave a value of $\Delta H(0^\circ\text{K}) = 20$ kcal/mole.

539.19

6218. DIPOLE FORCES BETWEEN MACROMOLECULES. F.Kroupa.

Czech. J. Phys., Vol. 7, No. 3, 374-5 (1957). In Russian.

An attempt at evaluating the permanent dipole moment which is

presumed to be the cause of chains and rings formed from macro-molecules (akin to proteins in composition) during the first stage of bacteriophage formation. Assuming that these chains and rings are built of elastic spheres (modulus of elasticity 3×10^9 dyne/cm²), the dipole moment is calculated to equal 360 Debye for a finite-length dipole (pole distance 100 Å), and 660 Debye for a point dipole.

F.Lachman

539.19

6219. POLYMERS AND THEORY OF NUMBERS. I. THE SINGLE-CHAIN THEORY OF DEGRADATION.

V.S.Nanda and R.K.Pathria.

J. chem. Phys., Vol. 30, No. 1, 27-30 (Jan., 1959).

The process of degradation of linear polymers was studied in terms of a corresponding problem in the theory of numbers. On the basis of this analogy, an exact single-chain theory is developed. Expressions for the size distribution among the various fragments and the different averages of the molecular weight are derived. It is shown that the results obtained by earlier authors from probability considerations follow as first approximations from the exact ones obtained here.

539.19

6220. POLYMERS AND THEORY OF NUMBERS. II. THE N-CHAIN THEORY OF DEGRADATION. R.K.Pathria and V.S.Nanda.

J. chem. Phys., Vol. 30, No. 1, 31-4 (Jan., 1959).

See preceding abstract. The treatment of the degradation process, developed in analogy with a corresponding problem in the theory of numbers, was extended to a polymer system in which the distribution of cuts over the member chains is purely random. The problem was solved in two steps and an N-chain theory was hereby developed. Next, in order to determine the various moments and the averages of the distribution, the technique of the "compound generating function" was introduced. Further potentialities of the new technique are indicated briefly.

539.19

6221. POLYMERS AND THEORY OF NUMBERS. III. SOME REMARKS ON THE THEORIES OF RANDOM DEGRADATION. V.S.Nanda and R.K.Pathria.

J. chem. Phys., Vol. 30, No. 1, 35-6 (Jan., 1959).

See preceding two abstracts. The number-theory technique developed to study the problem of degradation of polymers was used to resolve an important discrepancy that exists between the results obtained from the probability approach and results from a different approach used by Tuckett. Some other conclusions arrived at by Tuckett were also subjected to a critical examination.

SOLID-STATE PHYSICS

6222. MIDWEST SOLID-STATE PHYSICS CONFERENCE.

R.J.Friauf.

Phys. Today, Vol. 12, No. 3, 20-2 (March, 1959).

Report. The conference was held at the University of Kansas, Lawrence, on 1 November, 1958. Fifteen papers were contributed, dealing, inter alia, with masers and lasers (r.f. amplification), growth of crystal whiskers; electronic processes in solids, and the inert gases in the solid state.

539.2

6223. INVESTIGATIONS ON THE ADIABATIC APPROXIMATION IN SOLID STATE PROBLEMS. A.Haug and G.Sauermann.

Z. Phys., Vol. 153, No. 3, 269-77 (1958). In German.

Certain general points in the adiabatic approximation for solids are considered, and it is concluded that the usual procedures are somewhat dubious in places, though the final equations used in practice are satisfactory.

P.T.Landsberg

539.2

6224. MODELS OF INTERATOMIC FORCES IN SOLIDS.

Y.Le Corre.

J. Phys. Radium, Vol. 19, No. 8-9, 704-12 (Aug.-Sept., 1958). In French.

The different types of interatomic force in solids are reviewed and discussed. The general forms of the force constants $C_{\alpha\beta}^{gh}$, according to Born's and Laval's theories, are given. The coefficients

$C_{\alpha\beta}^{gh}$ are not α, β symmetric. The deviations from Cauchy's relations are caused not by the non-central forces, but by the fact that the crystalline periodicity is disturbed near the surface.

539.2

6225. DYNAMICS OF INTERACTING SPIN SYSTEMS.

R.T.Schumacher.

Phys. Rev., Vol. 112, No. 3, 837-42 (Nov. 1, 1958).

The dynamics of the approach of two spin systems to the same spin temperature is examined. It is found that for two spin systems in a rigid lattice interacting weakly with the lattice and with each other, differential equations governing the time rate of change of the spin temperatures can be derived. The derivation assumes the validity of the concept of spin temperature and the validity of the principle of detailed balance applied to eigenstates of the spin Hamiltonians of the systems. The spin mixing experiments of Abragam and Proctor (Abstr. 2523/1958) provide evidence for the correctness of the differential equations thus derived. Additional experiments on spin-lattice relaxation times in NaBr, NaI, and NaCl are reported and interpreted in terms of the differential equations developed here. It is shown that under certain conditions the presence of a second spin system can shorten the relaxation time of a spin system even at rather high values of the external field.

539.2

6226. A REVIEW OF RECENT WORK ON DIAMOND.

E.W.J.Mitchell.

J. Phys. Chem. Solids, Vol. 8, 444-9 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The following properties are discussed: the intrinsic absorption spectra (5.4 eV and 3 to 6 μ) and the various extrinsic absorption features; the electrical and optical properties of semiconducting diamonds; the luminescence of diamonds and the study of the symmetry of the centres from the polarization of the emission; and the optical spectra associated with radiation induced defects and their effect on the electrical properties of semiconducting diamonds.

539.2 : 548.735

SOME RELATIONS BETWEEN CRYSTAL STRUCTURES.

See Abstr. 5255-6

539.2

6227. ATOMIC FORCE CONSTANTS OF COPPER FROM FEYNMAN'S THEORY. H.C.White.

Phys. Rev., Vol. 112, No. 4, 1092-105 (Nov. 15, 1958).

In the Born-Oppenheimer approximation atomic force constants determine the elastic and vibrational behaviour of crystals for small nuclear displacements. The first-through third-neighbour force constants in the copper crystal are found as the components of the change in force produced on the nuclei when in equilibrium positions by the infinitesimal unit displacements of one nucleus. By Feynman's theorem quantum-mechanical forces can be calculated directly from the electronic and nuclear charge distribution by Coulomb's law. The Slater-Koster formalism developed for localized perturbations in crystals is used to find the change in conduction electron charge density resulting from the infinitesimal unit displacement of a nucleus. Free-electron wave functions are used, and most of the perturbation energy matrix elements are neglected. Calculations are made for small crystals with up to 2048 atoms and two different shapes (Born-von Kármán boundary conditions). First-order perturbation theory gives exact results for atomic force constants. An approximate Thomas-Fermi calculation is also carried out for the perturbation in conduction electron density and simple approximations of this perturbation are discussed. The ion cores are assumed to move nearly rigidly, and their closed-shell repulsion is chosen so that the calculated atomic force constants lead to the values of the elastic constants found experimentally. The nine calculated atomic force constants are quite different from the values Jacobsen inferred from thermal diffuse X-ray scattering from a copper crystal.

539.2

6228. THE NATURE OF BINDING IN CADMIUM TELLURIDE.

G.F.J.Garlick, J.M.Hough and R.A.Fatehally.

Proc. Phys. Soc., Vol. 72, Pt 5, 925-6 (Nov., 1958).

Measurements of refractive index with an infrared microscope (apparent depth method) are compared with values of low frequency dielectric constant. The results together with other data suggest that the binding is predominantly co-valent.

G.F.J.Garlick

539.2

6229. FERMION-THOMAS ANGULAR-DEPENDENT POTENTIAL FOR IRON. D.M.Hum.
Proc. Phys. Soc., Vol. 73, Pt 4, 650-60 (April, 1959).
A method is developed for determining the angular-dependent solution of the Fermi-Thomas equation for the potential within a body-centred or face-centred cubic lattice, calculations being performed for iron. By comparison with the spherically symmetric solution of the form obtained by Slater and Krutter it is possible to obtain estimates of the errors involved in the use of a spherically symmetric potential field. For iron the correction to the potential causes an increase of 0.56 eV in energy of the Fermi level, a decrease of 1.32 eV in the potential energy barrier between atoms and an increase of 3.0 eV in the total energy per atom. The total energy per atom of any metal, in the angular-dependent case, is reduced to a sum of integrals over the surface of the atomic polyhedron.

539.2

6230. CALCULATION OF LATTICE VIBRATIONS IN CRYSTALS WITH ZINC BLENDE STRUCTURE. I. LATTICE VIBRATIONS IGNORING COULOMB FIELD. L.Merten.
Z. Naturforsch., Vol. 13a, No. 8, 662-79 (Aug., 1958). In German.
Dynamical equations are set up in which forces between 1st, 2nd, and 3rd nearest neighbours are taken into account. The magnitudes of these forces are derived from the measured elastic constants. There are disagreements with the observed spectrum which are attributed to the neglect of Coulomb forces; these will be treated in a later paper. A.R.Stokes

539.2

6231. CALCULATION OF LATTICE VIBRATIONS IN CRYSTALS WITH ZINC BLENDE STRUCTURE. II. EFFECT OF COULOMB FIELD ON THE LATTICE VIBRATIONS. L.Merten.
Z. Naturforsch., Vol. 13a, No. 12, 1067-80 (Dec., 1958). In German.
For Pt I, see preceding abstract. The effect of the Coulomb field is worked out for the crystal structures InSb and ZnS; it is small for InSb but considerable for ZnS. A.R.Stokes

539.2

6232. OBSERVATIONS OF HYDROGEN VIBRATION FREQUENCIES IN PHOSPHATES BY MEANS OF INELASTIC SCATTERING OF COLD NEUTRONS.
I.Pelah, I.Lefkowitz, W.Kley and E.Tunkelo.
Phys. Rev. Letters, Vol. 2, No. 3, 94-5 (Feb. 1, 1959).
The time-of-flight spectra of scattered neutrons were measured on polycrystalline samples of K_3PO_4 , K_2HPO_4 and KH_2PO_4 and the appropriate observed peaks related to the vibration modes of H atoms. The associated energies correspond to smaller wave-numbers than have been observed by other workers. J.Thewlis

539.2 : 535.34

6233. LOW-FREQUENCY LIBRATIONS AND THE VIBRATIONAL SPECTRA OF MOLECULAR CRYSTALS. II. R.M.Hexter.
J. molecular Spectrosc., Vol. 3, No. 1, 67-72 (Feb., 1959).
The effect of libration of molecules in molecular crystals upon the observed dichroic ratios of their internal molecular vibrational absorption bands is discussed. A relationship previously derived is obtained in a more rigorous manner. The procedure demonstrates the need for integrated band intensities in calculating dichroic ratios. In the special case of "normal incidence" (electric vector perpendicular to c axis) spectra of uniaxial but anisotropic crystals, the more rigorous approach results in the selection rule forbidding a "Q" branch. The observation of such Q branches in several independent studies contradicts this rule. Possible reasons for this contradiction are discussed.

539.2 : 548.732

ELASTIC WAVE VELOCITY EFFECT ON TEMPERATURE DIFFUSE SCATTERING IN CUBIC POWDERS. See Abstr. 5254

539.2

6234. BAND THEORY. J.C.Slater.
J. Phys. Chem. Solids, Vol. 8, 21-5 (Jan., 1959).
Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). General survey of recent important advances. 11 references.

539.2

6235. BAND STRUCTURE AND TRANSPORT PROPERTIES OF SINGLE-CRYSTAL GRAPHITE. D.E.Soule and J.W.McClure.
J. Phys. Chem. Solids, Vol. 8, 29-35 (Jan., 1959).
Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The band model is consistent with group theory and fundamental calculations. The most important features of the model are: the valence and conduction bands overlap by about 0.03 eV; there are about 10^{-5} per atom of both electrons and holes at absolute zero contained in highly anisotropic (12 to 1) Fermi surfaces; the effective masses in the basal plane are 0.03 m_0 for electrons and 0.06 m_0 for holes; and there is fine structure warping near the ends of the Fermi surfaces. Thus, systematic studies can be made of doping and electron scattering. In the lattice-scattering region (for present samples $> \sim 25^\circ K$), the mobilities obey a $T^{-1.2}$ law. This temperature-dependence can be understood on a simple deformation-potential theory. The "knee" in the resistivity temperature curve at $\sim 110^\circ K$ can be accounted for by a transition with increasing temperature from degenerate to classical behaviour. While the above results are encouraging, the explanation of the exact origin of the large diamagnetic susceptibility is believed to be as yet unsatisfactory.

539.2

6236. THE SEMI-EMPIRICAL APPROACH TO BAND STRUCTURE. E.O.Kane.
J. Phys. Chem. Solids, Vol. 8, 38-44 (Jan., 1959).
Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). A review of the $\vec{k} \cdot \vec{p}$ approach to band structure. An effective Hamiltonian for the cell-periodic part of the Bloch function consists of diagonal elements corresponding to the band energies at $\vec{k} = 0$ and off diagonal elements of $(\hbar/m) \vec{k} \cdot \vec{p}$ connecting the bands and causing mutual repulsion unless symmetry forbids interaction. When $(\hbar/m) \vec{k} \cdot \vec{p}$ is small compared to the energy separation between bands, second order perturbation theory can be used to obtain effective masses. E versus k^2 expressions involve a small number of parameters which are determined by experiments such as cyclotron resonance. Perturbation theory can be improved upon by treating strongly interacting bands exactly and subsequently handling weak interactions by perturbation theory. Such a procedure inevitably increases the number of parameters to be determined. Optical band gap measurements are needed for this extension. In addition, absolute optical absorption determines momentum matrix elements between bands. The feasibility of using such an approach to determine band structure empirically throughout the zone is examined. In addition to $\vec{k} \cdot \vec{p}$, there are less important $\vec{k}$ -dependent terms which must be considered in some cases. The linear $\vec{k}$ terms at $\vec{k} = 0$ in the III-V compounds are an example. The inclusion of exchange terms in the one particle Schrödinger equation introduces modifications in the above treatment. The interband matrix elements determining the effective mass contain contributions from both momentum and exchange terms, whereas optical absorption involves only the momentum matrix element. Exchange terms contribute first order perturbation corrections to the effective mass. Estimates of exchange effects indicate that they are small. The symmetry approach of Luttinger (Abstr. 5090/1956) may serve to indicate inadequacies of the one particle viewpoint.

539.2

6237. ENERGY-BAND INTERPOLATION SCHEME BASED ON A PSEUDOPOTENTIAL. J.C.Phillips.
Phys. Rev., Vol. 112, No. 3, 685-95 (Nov. 1, 1958).
The scheme depends on only a few parameters. This is achieved by observing that the effect potential for electrons near the Fermi level can be split into two parts, the part due to the core, and the part due to other valence electrons. It is assumed that for semiconductors the relative effect of the core is small, so that it can be replaced by an effective repulsive potential. In this way two-parameter pseudopotentials are constructed for diamond and Si that give good agreement with orthogonalized plane wave calculations and experiment at special points of the Brillouin zone, and also yield reasonable results for the bands at other points of the zone. A by-product of the calculations is the discovery of an error in the model for the valence bands of Si near the centre of the zone proposed by Dresselhaus. A compromise model is proposed in good agreement with theory and experiment. Good results are obtained for Ge with a three-parameter pseudopotential. The many experimental facts that have been deduced about the band structures of Si and Ge are augmented by the results of the pseudopotential calculations to yield fairly accurate ($\delta E < \sim 0.05$ ry) sketches of the energy bands of these crystals along the [100] and [111] directions in the neighbourhood of the energy gap.

539.2

6238. STUDY OF THE WURTZITE-TYPE BINARY COMPOUNDS. III. VALENCE BAND STRUCTURE OF BeO. W.O'Sullivan.
J. chem. Phys., Vol. 30, No. 2, 379-83 (Feb., 1959).
For Pt II, see Abstr. 9982 (1957). The LCAO approximation is applied toward a description of the valence band in BeO, in which

only the closed shell $\text{Be}(1s)^2\text{O}(2p)^6$ configuration is considered. Thus no account is taken of the deformation of the oxygen valence electron distribution by the polarization field along the c axis of the wurtzite-type crystal. The problem is solved along several lines of symmetry in the hexagonal Brillouin zone. A bandwidth of 18 eV with a depth of approximately 7 eV is found.

539.2 : 537.311.33

6239. STATE DENSITY IN THE VALENCE BAND OF SILICON.

H.D.Hagstrum.

J. Phys. Chem. Solids, Vol. 8, 211-16 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The distribution in kinetic energy of electrons ejected by the Auger neutralization of 10 eV He^+ ions at a clean silicon surface is related through an integral transform to the state density function in the valence band. Estimates of the width of the degenerate p -band and of the total valence band are obtained from the fitting of a theoretical distribution to the experimental one.

539.2

6240. VALLEY-ORBIT SPLITTING OF ARSENIC DONOR GROUND STATE IN GERMANIUM.

G.Weinreich, W.S.Boyle, H.G.White and K.F.Rodgers.

Phys. Rev. Letters, Vol. 2, No. 3, 96-8 (Feb. 1, 1959).

Evidence is presented that the lowest lying state for the donor electrons is in this case the triplet rather than the singlet state. The method utilizes the fact that under a $\langle 111 \rangle$ uniaxial compression a $(1s \rightarrow np)$ absorption line is split, the more intense component suffering a red-shift for a triplet ground state (a blue shift would indicate a singlet ground state).

P.T.Landsberg

539.2

6241. THE ELECTRONIC STATES OF HARD SUBSTANCES WITH THE SODIUM CHLORIDE STRUCTURE.

H.Bilz.

Z. Phys., Vol. 153, No. 3, 338-58 (1958). In German.

The band model is used to determine the energies of the electronic states of hard substances (borides, carbides, nitrides and silicides of transition metals of groups IV to VI). A qualitative account of the physical properties of those substances is given in terms of the band structure, and comparisons made with a model based on directed valences.

J.Franks

539.2

6242. ELECTRON INTERACTION IN SOLIDS. CHARACTERISTIC ENERGY LOSS SPECTRUM.

P.Nozières and D.Pines.

Phys. Rev., Vol. 113, No. 5, 1254-67 (March 1, 1959).

The characteristic energy loss spectrum of solids is analysed with the aid of the dielectric formulation of the many-body problem developed by the authors. It is shown that a measurement of the angular distribution of inelastically scattered fast electrons is a direct measurement of the imaginary part of the inverse dielectric constant of the solid, at the frequency and momentum of the energy transfer to the electrons in the solid. The calculations of the dielectric constant by means of first-order perturbation theory and within the random phase approximation are discussed with regard to their implications for the characteristic energy loss spectrum. It is shown that plasmons provide the dominant excitation mode at low momentum transfer for the free electron gas and for most solids; an explicit calculation is given of the role of screening in reducing the role of the independent electron excitations in this region. A comparison is made between characteristic energy loss experiments and other techniques for exploring the energy level structure of solids, including the non-relativistic Compton effect, optical transmission and reflection experiments, and X-ray emission and absorption studies. An analogous formulation of the optical properties of solids is given, which shows that in general the transverse and longitudinal dielectric constants will not be equal. They are equal within the random phase approximation, so that a careful comparison of optical data with characteristic energy loss data permits a direct verification of the validity of the random phase approximation. Such a comparison likewise yields information on the magnitude of the screening of individual electron transitions and permits the unambiguous identification of plasmon excitations. Finally it is shown that to the extent that the random phase approximation is valid, the results of a characteristic energy loss experiment may be used for a direct experimental determination of the groundstate energy of the electrons in a solid.

539.2

6243. ELECTRON-PHONON INTERACTION IN METALS.

I. THE HARMONIC APPROXIMATION.

G.V.Chester and A.Houghton.

Proc. Phys. Soc., Vol. 73, Pt 4, 609-21 (April, 1959).

The problem of electron-phonon coupling is investigated using

the Born-Oppenheimer expansion. The expansion is carried out to second-order in the expansion parameter $(m/M)^{1/4}$. It is shown that to this order the expansion can be conveniently generated by a canonical transformation. The advantage of the canonical transformation is that a direct comparison can be made with the usual theories of the electron-phonon interaction. The frequency spectrum, and matrix elements of the electron-phonon interaction, of a monovalent metal are calculated and shown to be essentially identical with those derived by Nakajima and Bardeen and Pines. To second-order in $(m/M)^{1/4}$ the effects on the specific heat and spin susceptibility are calculated and found to be negligible at all temperatures.

539.2

6244. ELECTRON SELF-ENERGY APPROACH TO CORRELATION IN A DEGENERATE ELECTRON GAS.

J.J.Quinn and R.A.Ferrell.

Phys. Rev., Vol. 112, No. 3, 812-27 (Nov. 1, 1958).

A new method of computing the correlation energy of a degenerate electron gas is presented in which the interactions are studied by considering the self-energy of a lone particle impurity in the system. The self-energy results as in quantum electrodynamics from the action of the proper field set up by the charged particle back on itself; the Feynman space-time formulation of quantum mechanics is employed in the self-energy calculation, which is carried out along lines already laid out by Lindhard. The Feynman propagator, which takes the particle from one point in space-time to another, is derived. A slight, but essential, change in the particle propagator is needed to allow for exchange effects when the particle impurity is an additional electron in the degenerate electron gas. This gives the electron gas a dual role: it acts as a dielectric medium which can be polarized and also as a vacuum from which electron-hole pairs can be created and undergo exchange with incident electrons. The polarization propagator for the effective potential set up by the impurity in the electron gas, considered as a dielectric medium, is derived heuristically from Lindhard's dynamic dielectric constant and more rigorously from the momentum-exciton model. The electron self-energy is a Feynman integral involving the particle and polarization propagators and defines an optical potential which is found to have both real and imaginary parts. For momenta less than the Fermi momentum, it is shown that the optical potential is simply the negative of the self-energy of a hole in the Fermi sea. The imaginary part of the optical potential for an electron of momentum p is proportional to $(p/p_0 - 1)^2$ (where p_0 is the Fermi momentum), and gives rise to damping. Thus the concept of a one-electron state is only valid for small excitation energies and breaks down when the electron is appreciably far removed from the Fermi surface. The mean free path for high electron density is given (in units of $\hbar/p_0$) by $3.98r_s^{-1/2}$ times the above function of momentum. (r_s is the unit-sphere radius in Bohr radii.) The derivative of the real part of the optical potential with respect to momentum, evaluated at the Fermi surface, gives a correction to the specific heat in agreement with Gell-Mann. The value of the optical potential itself is related by Seitz's theorem to the derivative of the correlation energy with respect to density. Integration over density yields an expression for the ground state energy which agrees with the results of other investigators. Finally a brief discussion is given of Bethe's theorem, which directly relates the optical potential to the ground state correlation energy per particle. Although Bethe's theorem is not valid for the idealized electron gas with uniform positive background, it does apply to actual metals in equilibrium.

539.2

6245. MODIFIED BOHM AND PINES COLLECTIVE DESCRIPTION OF ELECTRON INTERACTIONS IN CRYSTALS. I.

J.Śledzik.

Acta phys. Polon., Vol. 17, No. 6, 463-79 (1958).

The generalized Bohm-Pines theory of electron interaction in translation lattices is formulated. In order to remove the difficulties in normalizing the state vectors a set of new subsidiary conditions is proposed. As a result it is shown that the Bohm-Pines theory may be taken as correct for any desired degree of accuracy. In this treatment the electrons are supposed to be bound with ion-cores (tight binding approximation). The ion-core polarization is not taken into account.

539.2

6246. ELECTRON DISTRIBUTION AND ENERGY BANDS IN CRYSTALS OF METAL BORIDES OF THE TYPE MB_6 .

S.Flodmark.

Ark. Fys., Vol. 14, Paper 33, 513-50 (1959).

Hybrids of s , p and d orbitals of the atomic L and M shells are used to describe the distribution of the valence electrons of the boron atoms in metal borides of the type MB_6 . The linear combinations of the hybrid orbitals, which form a basis for the different irreducible representations of the symmetry group O_h , are found.

Using these orbitals, Bloch wave-functions are constructed. In a one-electron approximation, the corresponding secular equations were solved numerically. The results show that the M-shell orbitals are very important for the explanation of the high stability of the crystal. The experimentally found conductivities of the crystals of type MB_6 are explained theoretically on the basis of conduction bands.

539.2

6247. ON THE DEFORMATION OF THE ELECTRON CLOUDS OF ATOMS AND THE POTENTIAL ENERGY OF SODIUM CHLORIDE. V.Hovi.

Ann. Acad. Sci. Fennicae A VI, No. 17, 17 pp. (1959).

Expressions for the electron density of chlorine and sodium atoms in sodium chloride are derived from the experimental X-ray data of Wasastjerna and Witte and Wölfel. From these expressions one can see that these two experimental investigations will give, for the electron density, values which are, at the distances $r > 0.4$ Å from the nuclei, in very good agreement. The results calculated from Wasastjerna's data would indicate a slight deviation from the spherical symmetry of the charge distribution in a sodium chloride lattice. This is in agreement with other recent work. The results obtained will provide additional evidence of the overlapping effect in ionic crystals, the effect taken into account by Lowdin in his quantum mechanical investigations. Great importance is attached to the deviation of the charge distribution from the spherical symmetry for the quantum mechanical calculations of the compressibility.

539.2

6248. ELECTRON DENSITY IN ATOMS OF SODIUM CHLORIDE ACCORDING TO THE FOURIER SERIES AND INTEGRAL METHODS. V.Hovi, K.Mansikka and Y.Pautamo.

Ann. Acad. Sci. Fennicae A VI, No. 19, 7 pp. (1959).

Values for the radial electron density of the chlorine and sodium ions in a sodium chloride lattice have been calculated by means of the Fourier series method on the basis of the experimental data of Witte and Wölfel. These values were compared with those determined with the aid of the Fourier integral method in preceding abstract. It is shown that these methods lead to a very good agreement. The results obtained for the electron density of the chlorine ions in the direction of (hhh) would indicate a slight deformation in the outer shells of these ions. On the other hand, for the sodium ions no effect of that kind was found.

539.2

6249. THE POSSIBILITY OF SPONTANEOUS IONIZATION IN A SYSTEM OF INTERACTING ELECTRONS IN A CRYSTAL. M.S.Svirskii and S.V.Vonsovskii.

Fiz. Metallov i Metallovedenie, Vol. 4, No. 3, 392-9 (1957). In Russian.

539.2 : 537.311.33

6250. ELECTRONIC PROCESSES AT GRAIN BOUNDARIES. L.Sosnowski.

J. Phys. Chem. Solids, Vol. 8, 142-6 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The electrical properties of grain boundaries of several kinds, such as the low angle boundary and the coherent and incoherent twin boundaries, are discussed in connection with experimental work on Si and Ge crystals. The nature of the boundaries was established by optical, X-ray, and electron microscopy methods. Diffusion of minority carriers, recombination rates, photovoltaic effects, and transient phenomena were investigated. The occurrence of n-p-n junctions at some types of boundaries is assumed. The experimental data are discussed in terms of the density of electronic states at the boundary.

539.2

6251. ENERGY EIGEN-VALUES OF AN ELECTRON IN A ONE-DIMENSIONAL PERIODICALLY-DISLOCATED LATTICE WITH A DEFECT. S.Okada.

Sci. Rep. Tohoku Univ. First Ser., Vol. 39, No. 4, 194-204 (Feb., 1956).

Energy eigenvalues of an electron are considered for a one-dimensional crystal lattice having a defect. The energy spectrum consists of discrete levels and continuous bands. Periodic displacements of the constituent atoms of the periodic parts of the crystal affect the energy spectrum; the displacements are assumed as follows. The first neighbour atom of the defect displaces by a certain distance from its equilibrium position in the original periodic lattice. The second neighbour atom displaces by the same distance but in the opposite direction to the first neighbour atom. The third neighbour

atom does not displace from its regular position. The fourth neighbour atom displaces in the same way as the first neighbour atom, and so on. This mode of dislocation of the constituent atoms continues periodically over the lattice. It is found that the discrete levels due to the defect for the original regular lattice vary their energies and each continuous band for the periodic lattice splits up into three continuous bands and two discrete levels.

539.2

6252. AN EIGEN-VALUE PROBLEM OF AN ELECTRON IN A ONE-DIMENSIONAL CRYSTAL LATTICE WITH A DEFECT. S.Okada.

Sci. Rep. Tohoku Univ. First Ser., Vol. 41, No. 1, 1-7 (Sept., 1957).

For previous work see preceding abstract. A simple method is derived for obtaining energy eigenvalues of an electron for a one-dimensional periodic potential field having a defect, assuming that the problem for the periodic potential field without the defect is solved. The eigenvalue spectrum consists of two sets: allowed bands, which are the same as for the periodic potential field without the defect, and discrete levels, which exist in each so-called forbidden band. For the case in which the potential is symmetrical with respect to the centre of the defect, the formulae determining energy eigenvalues become simple. A numerical example is given.

539.2 : 535.343

6253. DIAMAGNETIC EXCITON LEVELS AND CYCLOTRON RESONANCE. E.F.Gross, B.P.Zakharchenya and P.P.Pavinskii. Zh. tekhn. Fiz., Vol. 27, No. 9, 2177-80 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 9, 2018-22 (Sept., 1957).

New effects are reported in the absorption spectra of Cu_2O under the action of a magnetic field. The continuous absorption of the exciton in the magnetic field begins at energy value $\hbar\Omega$, where Ω may be called the "cyclotron frequency of the exciton" and is equal to the arithmetic mean of the cyclotron frequencies of the hole and electron, forming the exciton.

C.A.Hogarth

539.2

6254. FINE STRUCTURE IN THE ZEEMAN EFFECT OF EXCITONS IN GERMANIUM.

K.J.Button, L.M.Roth, W.H.Kleiner, S.Zwerdling and B.Lax. Phys. Rev. Letters, Vol. 2, No. 4, 161-2 (Feb. 15, 1959).

The observed energy levels are given as functions of the magnetic field H . A simple theory is developed, based on the spin Hamiltonian derived by considering the symmetry properties of the (indirect) exciton band edge. Experimental results with H along the (1,0,0) and (1,1,1) directions could be fitted reasonably well with the same set of parameters. An interpretation of these coefficients is considered. Observations of the Zeeman effect of the direct exciton were also made.

L.Pincherle

539.2

6255. ELECTRONIC STRUCTURE OF THE EXCITON IN IONIC CRYSTAL. FURTHER DISCUSSION OF A LOCALIZED EXCITON (ZERO-TH ORDER DESCRIPTION) AND GENERAL FORMULATION OF A MOVING EXCITON IN ALKALI HALIDES.

T.Muto, S.Oyama and H.Okuno. Progr. theor. Phys., Vol. 20, No. 6, 804-21 (Dec., 1958).

See also short account in: J. Phys. Chem. Solids, Vol. 8, 286-9 (Jan., 1959).

The common characteristics are discussed of previous theories of an exciton in an ionic crystal. A new approach to the exciton problem is proposed, in which the one-electron orbital is shown to yield some of the characteristic properties of an exciton, an α -exciton (an exciton localized in the immediate vicinity of a negative ion vacancy) and an X-ray exciton. A general formulation of a moving exciton, based on this one-electron orbital, is developed for the alkali halides, and an estimate is made of a singlet exciton peak in KCl. The effect of spin-orbit coupling on an exciton multiplet is discussed and a possible interpretation is presented of the doublet splitting of the exciton peaks in KCl and NaCl below 150°K, as recently observed by Hartman, Nelson and Siegfried. Slater and Shockley's theory of an exciton is compared with the present theory, and the latter is concluded to be more suitable for a small size exciton. [The shortened version was presented at the "International Conference on Semiconductors", Rochester, U.S.A., 18-22 Aug. 1958].

the fundamental absorption nearly coinciding with the absorption lines. Some of these may have appeared as a result of annihilation of excitons with the emission of light. Some of the crystals show a fine structure of the spectral dependence of photoconductivity which is closely related to the line structure of the absorption edge. This reveals the role of excitons in photoconductivity.

539.2 : 537.312.5

6256. ANALYSIS OF MIXED AMBIPOLAR AND EXCITON DIFFUSION IN CdS CRYSTALS.

G. Diemer, G. J. van Gurp and W. Hoogenstraaten. Philips Res. Rep., Vol. 13, No. 5, 458-84 (Oct., 1958). See also short account in: J. Phys. Chem. Solids, Vol. 8, 182-7 (Jan., 1959).

A detailed description is given of an investigation of the photoconductive response of CdS crystals to exciting radiations in the wavelength range $3000 \text{ \AA} < \lambda < 7500 \text{ \AA}$. Contributions from many sources, including those from fluorescent light and crystal inhomogeneities, are either eliminated or corrected for, giving results that are attributed to exciton migration over distances of up to 3 mm at room temperature. Factors that are considered favourable for the detection of exciton migration are discussed. [The shortened version was presented at the "International Conference on Semiconductors", Rochester, U.S.A., 18-22 Aug., 1958]. R.F. Peart

539.2

6257. ON THE THEORY OF EXCITONS IN SOLIDS. H. Haken.

J. Phys. Chem. Solids, Vol. 8, 166-71 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The different kinds of excitons are considered, taking into account the electron-electron interaction as well as the electron-lattice interaction. Some earlier results published by Toyozawa, Heller and Marcus are obtained as special cases. A refined theory of dielectric screening due to lattice vibrations is given. Optical properties of excitons with large orbital radii are discussed. Certain selection rules as well as a possible explanation of dichroic effects are given and compared with the corresponding ones of impurity atoms. A quantitative theory of the elementary process of energy transfer by excitons is given and compared with the resonance energy transfer process investigated by Dexter.

539.2 : 538.615 : 535.337

6258. OPTICAL SPECTRUM AND MAGNETO-OPTICAL PROPERTIES OF EXCITONS. E. F. Gross.

J. Phys. Chem. Solids, Vol. 8, 172-6 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). In a number of crystals at low temperatures, a complex structure of distinct strong lines at the edge of fundamental absorption is observed. There is reason to believe that the structure is connected with the creation of excitons predicted by Frenkel. In Cu_2O one can observe a hydrogen-like series of narrow lines:

$$\nu_n = \nu_\infty - \frac{B}{n^2}; \quad n = 2, 3, 4, 5, 6, 7, 8, 9, 10 \dots,$$

showing the existence of Mott excitons in the crystal. The fact that their diameters are very large is confirmed by ionization (dissociation) of excitons observed even in weak electric fields (1 kV/cm). The quadratic diamagnetic Zeeman effect is detected in Cu_2O and CdS, which is a proof of the large dimensions of excitons and their enormous diamagnetism. The linear paramagnetic Zeeman effect of the members of the Cu_2O series was not observed. That proves the existence of positronium-like excitons with equal effective masses of electron and hole. On the other hand some of the Cu_2O and CdS absorption lines show the linear Zeeman splitting only. This can be explained by excitation of localized excitons whose radii do not exceed the size of the crystal cell. In such a case, the spectra of ortho- and para-excitons may be different. Another phenomenon was observed in a magnetic field near the series limit of the Cu_2O exciton spectrum. A group of almost equidistant absorption maxima beyond the exciton series limit with a fine structure has been detected. These maxima are due to the diamagnetic levels of Landau. The spacing between successive maxima is determined by the exciton cyclotron frequency which is equal to the halfsum of the cyclotron frequencies of the electron and hole. In luminescence in a number of crystals, narrow emission lines are observed at the very edge of

539.2 : 538.222

6259. CRYSTALLINE FIELD SPLITTING OF Fe^{2+} ION IN FERROUS AMMONIUM SULFATE. T. Ohtsuka, H. Abe and E. Kanda.

Sci. Rep. Res. Insts Tohoku Univ. A, Vol. 9, No. 6, 476-91 (Dec., 1957).

The crystalline field splitting of the Fe^{2+} ion in ferrous

ammonium sulphate was studied by measuring the magnetic susceptibility of a single crystal at very low temperatures. The splittings obtained were discussed in connection with the linewidth of paramagnetic resonance absorption lines of added Mn^{2+} impurities in the ferrous salt. Very large splittings for the lowest levels were obtained and these values are compared with the magnetic specific heat data obtained by Hill and Smith.

539.2 : 538.245

6260. COMPLETE THEORY OF Ni(II) AND V(III) IN CUBIC CRYSTALLINE FIELDS. A. D. Liehr and C. J. Ballhausen.

Ann. Phys. (New York), Vol. 6, No. 2, 134-55 (Feb., 1959).

The generalized crystal field theory of Finkelstein and Van Vleck [J. chem. Phys., Vol. 8, 790 (1940)] is augmented by the introduction of spin-orbit coupling and an attempt is made to thus account for both the spin-allowed and the spin-forbidden d^n ($n = 2, 8$) spectral transitions of Ni(II) and V(III) complexes. The secular equations are derived by the use of functions which span, in both the weak and strong crystalline field pictures, the proper spin-coordinate cubic symmetry classification of Bethe. These secular equations were solved numerically and the results are illustrated by suitable graphs. The existing spectral data on tetrahedral and octahedral complexes of Ni(II) and V(III) have been interpreted theoretically and it is found that the calculations do not support Jorgensen's assignment of the double-peaked red band of hexaquo nickel systems. Spin-allowed infrared transitions are predicted at ~ 350 , 1000, 1100 and 5300 cm^{-1} for tetrahedral Ni(II) complexes and at ~ 1.6 , 168 and 250 cm^{-1} for octahedral V(III) complexes. Low's spectral data on divalent nickel dissolved in magnesium oxide and trivalent vanadium dissolved in aluminium oxide are given a rigorous theoretical interpretation. Some comments on the applicability of the derived transformation and energy matrices to the related magnetic problems (paramagnetic resonance and magnetic susceptibilities) and spectral problems (energy level splittings due to fields of lower symmetry) are given in the appendices. In particular, it is shown that the ground electronic state splitting of 0.49 cm^{-1} found by Holden et al. in nickel fluosilicate hexahydrate implies a 50 cm^{-1} trigonal field splitting of certain of the excited electronic states.

539.2

6261. THERMAL DIFFUSION OF VACANCIES IN ZINC. P. Shewmon.

J. chem. Phys., Vol. 29, No. 5, 1032-6 (Nov., 1958).

Thermal diffusion, or the Ludwig-Soret effect, can be described by adding to the isothermal flux equation a second term proportional to the product of the temperature gradient and Q^* , the heat of transport. The magnitude of Q^* for vacancies in zinc was determined by placing markers in a piece of pure zinc, which was then held in a temperature gradient near its melting point. No marker movement was observed in 20 days. Thus the net flux of vacancies was effectively zero so that the effect of the strong concentration gradient was cancelled by the thermal-diffusion force. This result is rationalized in a discussion of Q^* . A brief analysis of Q^* for solutes, other than vacancies, shows that in general Q_1^* will be approximated by the partial molar heat of solution of the solute, $\bar{H}_1$, where the pure solute is taken as the standard state. A survey of the available data for Q^* shows that the experimentally observed sign for Q^* is obtained in each case by taking simply $Q_1^* = -\bar{H}_1$.

539.2

6262. THERMAL MOTION IN ICE AND HEAVY ICE. A. Zajac.

J. chem. Phys., Vol. 29, No. 6, 1324-7 (Dec., 1958).

Changes with temperature of X-ray intensities of the 001 reflections in ice and heavy ice were investigated. From these the amplitudes of thermal motion of oxygen and hydrogen atoms are determined separately. This can be accomplished since only hydrogen atoms contribute to the 004 reflection. The thermal amplitudes of the oxygen atoms, which represent molecular amplitudes, can be expressed in terms of a constant Debye characteristic temperature: 224°K for ordinary ice and 237°K for heavy ice. The amplitudes of thermal vibration of the hydrogen and deuterium atoms, as derived from absolute intensities of 004 at various temperatures, cannot be expressed in terms of a characteristic temperature. They consist of superimposed stretching, bending and librational motions. In addition to these a rotational motion of low zero point energy seems to be present.

6263. THEORY OF COLD CRYSTALLIZATION OF HIGH POLYMERS. B.Wunderlich.
J. chem. Phys., Vol. 29, No. 6, 1395-404 (Dec., 1958).
The nonequilibrium limit of random crystallization of linear high polymers is described. Expressions for crystallite size, surface area, crystallinity, and amorphous sequence distribution of crystallizable repeating units in random copolymers after cold crystallization are derived. Melting points and change of crystallinity with temperature in the melting range are discussed. All partially crystallized polymers are found to fall between the two limits of equilibrium and random (or cold) crystallization. For the system poly (ethylene terephthalate-sebacate) enough data (ΔH_u , T_m^0 , crystal structure, and C_p as a function of temperature and composition) are available, so that the cold crystallization limit could be calculated.
6264. DEBYE CHARACTERISTIC TEMPERATURE AT 0°K OF CERTAIN CUBIC CRYSTALS. II. J.de Launay.
J. chem. Phys., Vol. 30, No. 1, 91-2 (Jan., 1959).
For Pt I, see Abstr. 5521 (1956). Tables are given which enable the easy computation of the Debye characteristic temperature at 0°K for certain cubic crystals from a knowledge of the elastic constants. These tables are for the range of elastic constant $0 \leq c_{12}/c_{44} \leq 3$ and $(c_{11}-c_{12})/2c_{44} \geq 1$. They include the range of elastic constants usually possessed by the alkali halides. A two-way interpolation formula is also given.
6265. DIELECTRIC AND THERMAL STUDY OF $(\text{NH}_4)_2\text{SO}_4$ AND $(\text{NH}_4)_2\text{BeF}_4$ TRANSITIONS.
S.Hoshino, K.Vedam, Y.Okaya and R.Pepinsky.
Phys. Rev., Vol. 112, No. 2, 405-12 (Oct. 15, 1958).
The behaviour of the various dielectric properties, specific heat, and thermal expansion of $(\text{NH}_4)_2\text{SO}_4$ and $(\text{NH}_4)_2\text{BeF}_4$ was studied in detail under various experimental conditions, with particular reference to the ferroelectric transitions in these crystals. The curves of dielectric constant v. temperature do not obey the Curie-Weiss law. The shift of the transition temperature as reported in the literature could not be detected even under extreme experimental conditions. The transition energy and entropy change were evaluated from a C_p -T curve. The variation of the lattice parameters and the unit cell volumes with temperature has been measured by the X-ray method. The transition of $(\text{NH}_4)_2\text{SO}_4$ appears to be of first order, while that of $(\text{NH}_4)_2\text{BeF}_4$ is also of first but very close to second-order. Deuteration of these crystals does not affect the transition of $(\text{NH}_4)_2\text{SO}_4$; but in the case of $(\text{NH}_4)_2\text{BeF}_4$ the transition temperature is raised by 3°C by deuteration, and the transition energy is also increased. The phase diagram of $(\text{NH}_4)_2\text{SO}_4$ - $(\text{NH}_4)_2\text{BeF}_4$ system is given.
6266. DONOR WAVEFUNCTIONS IN SILICON BY THE ENDOR TECHNIQUE. G.Feher.
J. Phys. Chem. Solids, Vol. 8, 486-9 (Jan., 1959).
Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The electron nuclear double resonance (ENDOR) method was applied to the investigation of ground state donor wave-function in silicon. The method enables one to determine the hyperfine interaction of the donor electron with the Si^{29} nuclei situated at different lattice sites with respect to the impurity. This gives one a value for the square of the electronic wave-function at different lattice points. Both the isotropic and anisotropic h.f. interactions for arsenic, phosphorous and antimony impurities were determined. By comparing the experimental results with the theory of Kohn and Luttinger one obtains for the value of the conduction band minimum in silicon $k_0/k_{\text{max}} = 0.85 \pm 0.03$.
6267. CLASSICAL NON-LINEAR LATTICE STATISTICS FOR ONE-DIMENSIONAL LATTICE FAULTS.
E.Fues, H.Stumpf and F.Wahl.
Z. Naturforsch., Vol. 13a, No. 11, 962-78 (Nov., 1958). In German.
The theory of elastically strained lattices (Abstr. 5080/1955) is extended to include elastic-plastic distortions; the effects of edge and screw dislocations are considered.
6268. X-RAY RECORDING OF DISTORTION FIELD ROUND ISOLATED DISLOCATIONS IN GERMANIUM SINGLE CRYSTALS.
U.Bonse and E.Kappler.
Z. Naturforsch., Vol. 13a, No. 4, 348-9 (April, 1958). In German.
A double crystal X-ray spectrometer arrangement of two germanium single crystals is used, with the crystals parallel, in order to show up imperfections on the etched surface of one of the crystals. Light-microscope photographs are shown for comparison.
6269. X-RAY DETERMINATION OF THE TYPE OF ISOLATED DISLOCATIONS IN SINGLE CRYSTALS. U.Bonse.
Z. Phys., Vol. 153, No. 3, 278-96 (1958). In German.
An arrangement like a two-crystal spectrometer is used (see preceding abstract) whereby X-rays are reflected first from a nearly "perfect" crystal and then from the specimen. Examples are given of "light-field" and "dark-field" photographs of dislocations, obtained at different parts of the rocking-curve. It is claimed that angular distortions of $0.8''$ and lattice-constant variations of 8×10^{-7} can be detected.
6270. INTERACTION OF DISLOCATION WITH ATOMIC ORDER IN SOLID SOLUTIONS. K.Sumino.
Sci. Rep. Res. Insts Tohoku Univ., Vol. 10, No. 4, 283-98 (Aug., 1958).
A mechanism is proposed for the interaction between a dislocation and the atomic order, due to the coupling of the stress field of the dislocation with lattice distortion accompanied by ordering in superlattice alloys. The interaction energy and the locking force against the motion of the dislocation are calculated for a superlattice of the β -brass type by using the quasichemical treatment developed by Iwata. The effect of thermal motion on the locking force is also considered on the basis of Suzuki's treatment. The interaction energy and the locking force for an edge dislocation reveal a sharp peak at the Curie point of order-disorder transformation, while such a sharp peak is absent in a screw dislocation. The values for a screw dislocation are found to be ~ 1 -10% of those for an edge dislocation. Furthermore, the short-range order hardening is expressed in terms of order parameters for the superlattice of the β -brass type.
6271. DEEP LEVEL IMPURITIES IN GERMANIUM. W.W.Tyler.
J. Phys. Chem. Solids, Vol. 8, 59-65 (Jan., 1959).
Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Reviews the properties of deep level impurities in germanium. With the exception of the well-known hydrogen-like impurities, all of the electrically active impurities which have been studied in detail act as multiple acceptors or donors introducing deep impurity levels ($\geq .03$ eV). The number and type of levels are consistent with the tetrahedral bonding model. As examples, Zn (with a $4s^2$ outer orbit configuration) acts as a double acceptor in Ge ($4s^2 4p^2$); Cu ($4s^1$) acts as a triple acceptor and Te ($5s^2 5p^4$) acts as a double donor. However, no theoretical treatment has proved adequate for calculation of the positions of energy levels for the deep level impurities. Hall coefficient studies have determined the positions of deep acceptor levels introduced into Ge by the elements Zn, Cd, Mn, Fe, Co, Ni, Cu, Ag and Au. Deep donor levels are introduced by S, Se and Te. For most of these impurities the positions of the energy levels have been confirmed by studies of extrinsic photoconductivity or optical absorption. Values of diffusivity and the temperature dependence of solubility are also known for many of these impurities. The interpretation of both steady state and transient photoconductivity studies has demonstrated the importance of the charge state at deep level impurities in determining recombination processes. At low temperatures, multiply charged negative centres are effective hole traps; multiply charged positive centres act as electron traps. Some quantitative values of capture cross-sections have been obtained for different charge states of multiple acceptor impurities. Reference is made to other electrical, optical and magnetic experiments made possible because of the present knowledge of deep level impurities in Ge and the control now possible over crystal preparation.

539.2

6272. QUENCHED-IN LATTICE VACANCIES IN COPPER.

G. Airoidi, G.L. Bacchella and E. Germagnoli.

Phys. Rev. Letters, Vol. 2, No. 4, 145-6 (Feb. 15, 1959).

Preliminary experiments are reported on the quenching and annealing of pure copper wires, of 0.04 mm and 0.07 mm diameter. Provided the quenching temperature is less than 1150°K the changes in resistivity (measured at room temperature) are exponentially dependent on T^{-1} for wires of either diameter. For 0.04 mm wires an activation for recovery of 1.3 eV was found and for 0.07 mm wires an energy of about 1.6 eV. The difference is related to the difference of cooling rates obtainable with the two wires and the consequent formation of complex defects due to the clustering of vacancies is responsible for the larger activation energy.

R. Bullough

539.2 : 548.735

SHADOWS OF DISLOCATION LINES IN X-RAY DIAGRAM.

See Abstr. 5257

539.2 : 535.34

ABSORPTION OF GERMANIUM IN THE NEAR INFRARED AND CRYSTAL DEFECTS. See Abstr. 5546

539.2 : 537.311.1

6273. THE PHYSICAL INTERPRETATION OF MEAN FREE PATH AND THE INTEGRAL METHOD. P.J. Price.

I.B.M. J. Res. Developm., Vol. 2, No. 3, 200-4 (July, 1958).

In previous papers (see Abstr. 8596 and 8736/1957) general expressions for the linear electronic transport constants of solids were obtained in terms of a conjugate function ψ^* related, by a linear inhomogeneous integral equation, to the function (of electron state) ψ measured by the "flux". It is now shown that

$$\tau\psi^* = \int_0^\infty \psi(t) dt,$$

where the integrand is the expectation of ψ for an electron which at time t earlier was in the specified state (of which ψ^* is a function) and $1/\tau$ is the collision frequency. In particular, the vector mean free path τv is: "the limit, after a virtually infinite time, of the mean displacement, in Brownian motion, of the position of an electron initially in the specified state." If there is a force (e.g. that due to a magnetic field) accelerating the electrons between collisions, then a linear transport constant is the same functional of an "extended conjugate" ψ^{**} as it is of ψ^* in the absence of the force. It is shown that $\tau\psi^{**}$ is obtained (instead of $\tau\psi^*$) when the integrand in the integral above is replaced by the "expectation after time t' " as modified by the accelerations between collisions. The relation of the present formalism to the Shockley-Chambers theory is discussed.

539.2 : 537.311.33

6274. HIGH-VACUUM STUDIES OF SURFACE RECOMBINATION VELOCITY FOR GERMANIUM. H.H. Madden and H.E. Farnsworth.

Phys. Rev., Vol. 112, No. 3, 793-800 (Nov. 1, 1958).

The surface recombination velocity s of minority carriers for (100) faces of germanium crystals was studied under various vacuum conditions. Values of mean lifetime were obtained by the decay-of-photoconductivity method and the corresponding values of surface recombination velocity were determined from geometrical considerations. Increases in s were observed due to initial evacuation of the experimental tube. Following outgassing of the samples in vacuum at temperatures above 500°C and for a time in excess of 30 hr, s was found to be insensitive to exposure to oxygen at pressures as high as 10^{-4} mm Hg. As a result of cleaning the surfaces of samples by the ion-bombardment technique, s increased to a value of $(5 \text{ to } 7) \times 10^3$ cm/sec. Heating the ion-bombarded crystals in vacuum at temperatures above 500°C for prolonged periods of time, followed by slow cooling, resulted in a decrease in s to a value below 500 cm/sec but greater than the value obtained following a CP-4 etch and the value obtained after pumping. The recombination velocity of clean and annealed (100) germanium surfaces was found to be insensitive to room-temperature adsorption of oxygen at pressures as high as 5×10^{-5} mm Hg. Exposure of these clean surfaces to oxygen at temperatures of about 100°C resulted in small decreases in mean lifetime, corresponding to a possible increase in s , assuming that this was entirely a surface phenomenon. The clean-surface value of s could be restored by heating at 500°C in vacuum for short periods of time. The characteristics of a well-outgassed oxide-covered surface and a clean surface are found to be similar. The observed similarities are discussed and the conclusion drawn that the oxide layer, of itself, has little or no effect on the surface recombination process.

539.2

6275. CALCULATION OF MIGRATION AND BINDING ENERGIES OF MONO-, DI-, AND TRIVACANCIES IN COPPER WITH THE USE OF A MORSE FUNCTION.

A.C. Damask, G.J. Dienes and V.G. Weizer.

Phys. Rev., Vol. 113, No. 3, 781-4 (Feb. 1, 1959).

A machine calculation was made of the migration and binding energy of a trivacancy in copper with the use of a Morse function. It was found that a very large relaxation occurs for one atom into the trivacancy. This relaxation causes the trivacancy to be shared equally by four atomic sites and results in a large contribution (about 2.3 eV) to the binding energy. The migration of a trivacancy requires a partial dissociation of this configuration. The energy of migration is calculated to be 1.9 eV. Thus, a trivacancy is highly stable, quite immobile and is, therefore, probably the nucleus for void formation. For purposes of comparison the migration energies of mono- and divacancies were also computed by the same method without relaxation. These energies are 1.3 and 0.2 eV, respectively.

539.2

6276. METALLIC TRANSITION IN LITHIUM HYDRIDE.

R. C. Behringer.

Phys. Rev., Vol. 113, No. 3, 787-92 (Feb. 1, 1959).

The dependence on lattice parameter, or pressure, of the energy gap between the last filled and first empty energy band in LiH is investigated. The crystalline potential is approximated by a Wigner-Seitz atomic-spheres potential, corrected to account for the effects of overlapping spheres, and the wave functions are expanded in symmetrized plane waves. In addition the effect of varying the relative size of the lithium and hydrogen ion spheres is considered. The energy levels at the top of the filled band and the bottom of the empty band are determined at several values of the lattice parameter, using 6, 7, 8, 9, and 10 symmetrized plane waves. The problem of convergence is examined. The model predicts that transition to the metallic state should occur at a pressure of about 35 megabars. The results are discussed in light of recent experimental investigations.

539.2

6277. SURFACE PROPERTIES OF ETCHED TUNGSTEN SINGLE CRYSTALS. F.L. Hughes, H. Levinstein and R. Kaplan.

Phys. Rev., Vol. 113, No. 4, 1023-8 (Feb. 15, 1959).

An examination of the surface properties of chemically etched W single crystals was made to determine the possibility of developing a macroscopic surface with adsorption properties equivalent to an ideal crystal plane. Crystals up to three inches in length were grown in 0.003 inch W wires by a thermal gradient technique. The crystals completely filled the wire cross-section. The etching appeared to have produced a surface which was homogeneous on a microscopic level. Thermionic emission was observed to be identical for the three crystallographic directions, [112], [112], and [110], with a value of $\phi_0^* = 5.25 \pm 0.05$ V. Surface ionization measurements gave the same value of the work function within experimental error.

539.2

6278. MEAN ADSORPTION LIFETIME OF Rb ON ETCHED TUNGSTEN SINGLE CRYSTALS: IONS.

F.L. Hughes and H. Levinstein.

Phys. Rev., Vol. 113, No. 4, 1029-35 (Feb. 15, 1959).

Using an interrupted atomic beam technique, the mean adsorption lifetime, τ_1 , was measured for Rb ions adsorbed on an "essentially clean" etched tungsten surface. Etching produced a homogeneous surface with a uniform work function. An estimated 90% of the surface consisted of microcrystal facets of the same crystallographic plane. The maximum Rb concentration was about 10^{10} atoms/cm². The data may be represented by the equation $\tau_1 = \tau_1^0 \exp(Q_i/kT)$, in the region $1100 < T < 1300^\circ\text{K}$. The weakly temperature-dependent term τ_1^0 appears to be affected by the shape, near the minima, of the ionic potential barrier of height Q_i . Lifetime measurements indicated that τ_1^0 and Q_i are strongly affected by the physical state of the metal and by the type and degree of contamination. It was found that τ_1^0 as well as Q_i must be used in characterizing "chemical" adsorption processes.

539.2

6279. MEAN ADSORPTION LIFETIME OF Rb ON ETCHED TUNGSTEN SINGLE CRYSTALS: NEUTRALS. F.L. Hughes.

Phys. Rev., Vol. 113, No. 4, 1036-8 (Feb. 15, 1959).

The mean adsorption lifetime was measured for the fraction of adsorbed Rb which was desorbed as neutral atoms from an etched W surface. The lifetime was found to be greatly different from that

obtained in the case of Rb ions. Experimental values were found to be consistent with a theoretical model which assumes that, in a surface ionization process, the adsorbed particles may occupy either of two discrete states with distinctly different types of binding.

539.2

6280. MULTIPLE TRAPPING SITES FOR HYDROGEN ATOMS IN SOLID ARGON. E.L.Cochran, V.A.Bowers, S.N.Foner and C.K.Jen. Phys. Rev. Letters, Vol. 2, No. 2, 43-5 (Jan. 15, 1959).

The electron spin resonance spectrum of H atoms, produced by photolysis of 1% HI in argon at 4.2°K by resonance radiation from a low pressure mercury lamp, comprises three doublets. These are interpreted as due to H atoms in three different lattice sites in the polycrystalline argon. They have different g values, hyperfine energy separations and annealing temperatures.

J.M.Baker

539.2 : 535.23.08

6281. SOLID STATE INFRARED QUANTUM COUNTERS. N.Bloembergen. Phys. Rev. Letters, Vol. 2, No. 3, 84-5 (Feb. 1, 1959).

A device is proposed in which there is an optical transition lying above an infrared transition in the energy level diagram of a crystal. The crystal is sufficiently cooled so that the electrons are in the lower state of the infrared gap. Hence there are none available for optical transitions until an infrared quantum is absorbed. Then, if the crystal is "optically pumped" strongly enough, there is the possibility that a single infrared quantum will trigger several optical transitions, which are counted with a photomultiplier.

D.Walsh

539.2

6282. CALCULATION OF THE INTERFERENCE LAYERS IN THE SCATTERING CURVES FOR COMPACT AMORPHOUS ELEMENTS. H.Richter. Z. Naturforsch., Vol. 13a, No. 1, 32-6 (Jan., 1958). In German.

The forms of the scattering curves for compact amorphous Si, Ge, Se, As, Sb were determined by superposition of interference functions. Calculated and observed values of the maxima in the scattering curves are tabulated and compared for Se and Sb.

G.C.Williams

539.2

6283. ON THE STRUCTURE SENSITIVITY OF GALLIUM TELLURIDE (Ga₂Te₃) AS A FUNCTION OF SMALL ADDITIONS OF Cu. G.Harbecke and G.Lautz. Z. Naturforsch., Vol. 13a, No. 9, 771-5 (Sept., 1958). In German.

Ga₂Te₃ has the zinc blende structure with one third of the Ga sites unoccupied. Traces of Cu from 10⁻⁶ to 10⁻¹ At. % of the Ga were introduced and several unexpected effects were observed. For Cu concentrations below 8 × 10⁻⁶ At. % a linear increase of lattice spacing up to 2.7% and a decrease in the energy gap down to 0.86 eV in comparison with the normal 1.55 eV. For concentrations of Cu > 10⁻⁵ At. % electrical and X-ray effects indicate larger effects and ultimately a new crystal phase is shown to exist.

C.A.Hogarth

539.2 : 535.37

6284. ON COLORATION AND LUMINESCENCE OF NaCl AND NaCl/Ag UNDER ELECTRON IRRADIATION. F.W.Geck. Z. Naturforsch., Vol. 12a, No. 7, 562-9 (July, 1957). In German.

NaCl crystals are strongly coloured by electrons and at high temperatures colloidal sodium can be produced. Absorption also occurs below 2000 Å, probably due to colloidal sodium. A F₀ band at 3900 Å is ascribed to a sodium atom in an anion vacancy. Silver activated sodium chloride is very strongly coloured by electrons and annealing produces colloidal silver. Electron irradiation reduces the luminescence efficiency of this material.

G.F.J.Garlick

539.2 : 535.37

ON THE STRUCTURE OF LUMINESCENCE CENTRES IN COPPER ACTIVATED ZINC SULPHIDE PHOSPHORS. See Abstr. 5556

539.2 : 538.27

NUCLEAR MAGNETIC RESONANCE STUDIES OF DOPED III-V COMPOUNDS. See Abstr. 5946

539.2 : 534.23

ACOUSTICAL ABSORPTION ARISING FROM MOLECULAR RESONANCE IN SOLIDS. See Abstr. 5455

539.21

6285. THE EFFECT OF CORPUSCULAR RADIATION ON THE CREEP PROPERTIES OF METALS. G.Saur, H.J.Laue and H.Borchers. Atomkernenergie, Vol. 4, No. 3, 98-104 (March, 1959). In German.

Critical review, with descriptions of typical apparatus, assessments of various techniques, and tabular and graphical data for several metals and alloys.

539.21

6286. FADING OF COLORATION OF IRRADIATED GLASS. S. Kondo. J. Phys. Soc. Japan, Vol. 13, No. 2, 224 (Feb., 1956).

Fading as a function of time is given by an equation whose exponential constants depend only on the glass used, the wavelength of the radiation, and the temperature. Good agreement with experiment over a wide temperature range is found.

D.V.Mabbs

539.21 : 535.371

6287. CHANGES IN TRAPPING LEVELS OF ZINC SULFIDE PHOSPHORS RESULTING FROM POSITIVE ION BOMBARDMENT. W.T.Allen and C.H.Bachman. J. Electrochem. Soc., Vol. 106, No. 3, 211-17 (March, 1959).

Utilizing a decay method which consisted of measuring the amount of visible light emitted by the ZnS:Ag phosphor 5.0 msec after excitation by weak ultraviolet, studies were made of the changes in trap distribution on the surface of phosphor crystals which previously had been bombarded by A⁺, H₂⁺, and O₂⁺ ions. Interpretation of results was limited to first order kinetics. The results showed that bombardment by ions caused an increase in the number of traps at the lowest trapping level, 0.28 eV deep, as well as the creation of new traps at depths slightly greater and slightly less than 0.28 eV. This effect was independent of the ion used for bombardment. In addition, ion bombardment caused new traps to appear at deeper trapping levels: 0.37 eV for A⁺ ion bombardment, 0.38 eV for H₂⁺ ion bombardment, and 0.39 eV for O₂⁺ ion bombardment. For the latter, the peak in the difference curve is quite sharp and clearly located at 345°K, locating its depth at 0.39 eV. This corresponds to the next trapping level with increasing depth reported in the literature and thus may indicate that this trapping level is caused by the presence of oxygen in ZnS phosphors.

539.21 : 539.23

6288. MISORIENTATION CAUSED BY IONIC BOMBARDMENT OF THIN MONOCRYSTALLINE OR STRONGLY ORIENTED METAL FILMS. J.J.Trillat, L.Tertian and N.Terao. J. Rech. Cent. Nat. Rech. Sci., No. 43, i56-63 (June, 1958). In French.

Ionic bombardment of thin films leads to disorder effects which the authors have studied by electron diffraction. Beaten foils of gold, silver and platinum were used as well as oriented films grown on sodium chloride crystals.

A.E.I. Research Laboratory

539.21 : 535.348

6289. COLORATION OF BIOTITES BY α-PARTICLES IN PLEOCHROIC HALOES. II. S.Deutsch and P.Janssens. Nuovo Cimento, Vol. 11, No. 4, 473-83 (Feb. 16, 1959).

For previous work, see Abstr. 977 (1958). The coloration was investigated as a function of the number of displaced atoms. The number was calculated by use of the theory of Seitz. The coloration increases, saturates and diminishes with increasing number of ions.

539.21

6290. DUCTILE-BRITTLE TRANSITION IN STEELS IRRADIATED WITH NEUTRONS. D.Hull and I.L.Mogford. Phil. Mag. (Eighth Ser.), Vol. 3, 1213-22 (Nov., 1958).

The yield and fracture stresses of unirradiated and irradiated En2 steel were measured at 20°, -78°, and -196°C. From the change in yield stress, σ_y (shear), with grain size, 2d, the values of σ₁ and k_y in a Petch type equation, σ_y = σ₁ + k_yd^{-1/2}, have been determined. The term k_y is unaffected by irradiation to within 5% and σ₁ increases at a rate approximately proportional to the cube root of the dose. The effect of irradiation on the grain size transition from ductile to brittle fracture was determined experimentally at -196°C and estimated from the change in σ₁ and the value of k_y for tests at -78° and 20°C. The results are in accord with the predictions of Cottrell's relation (σ₁ d^{1/2} + k_y) k_y = βγμ for the transition. The transition surface relating grain size, yield stress and temperature has been obtained.

- 539.21 : 539.12
6291. THE SCATTERING OF LONG WAVELENGTH NEUTRONS BY IRRADIATED AND UNIRRADIATED QUARTZ. E.W.J.Mitchell and P.T.Wedepohl. Phil. Mag. (Eighth Ser.), Vol. 3, 1280-6 (Nov., 1958).
 Measurements were made of the transmission of neutrons of wavelengths between 5 and 10 Å through 10 cm of unirradiated and pile-irradiated Brazilian quartz crystals. The total transmission cross-section of the unirradiated crystal varied as $\delta A = 0.55 + 1.63\lambda$ in the measured wavelength range. After irradiation with 6.4×10^{18} fast $n^0 \text{ cm}^{-2}$, as indicated by the $[S(n^0p)P]$ reaction, additional scattering was found. This amounted to 0.18 barns per molecule between 12 and about 9 Å rising continuously below 9 Å. The measurements are discussed in relation to optical absorption measurements and radiation damage theory.
- 539.21 : 539.531
6292. HARDNESS CHANGES IN ALKALI HALIDE SINGLE CRYSTALS PRODUCED BY DEUTERON BOMBARDMENT. R.Bock, E.Fuss and U.Schmidt-Rohr. Z. Naturforsch., Vol. 13a, No. 9, 797-9 (Sept., 1958). In German.
 RbCl, KCl, NaCl, NaF and LiF were all found to show an increase in hardness on irradiation with 10 MeV deuterons; the hardness reaches a saturation value (in LiF at 10^{15} deuterons/cm²), and the change is greatest in material of lowest atomic number. The effect of annealing and the changes in optical absorption and X-ray structure were also investigated and the results are qualitatively discussed. J.E.Caffyn
- 539.21 : 539.386
6293. RADIATION DAMAGE AND STRENGTHENING DUE TO IRRADIATION. A.Seeger. Z. Naturforsch., Vol. 13a, No. 1, 54-5 (Jan., 1958). In German.
 Describes a mechanism for radiation damage in metals and gives a formula for the critical shear stress τ_0 . The temperature dependence of τ_0 is in good agreement with experiment. D.M.Edwards
- 539.213
6294. STRUCTURE OF VITREOUS B_2O_3 . F.Herre and H.Richter. Z. Naturforsch., Vol. 12a, No. 7, 545-50 (1957). In German.
 An X-ray examination using $CuK\alpha$ and $MoK\alpha$ radiations was carried out on the solid (vitreous) form at 20°C and on the molten form at 450°C and 600°C. Radial atomic distribution curves were derived by Fourier inversion of the observed scattering curves. Comparison with calculated distribution curves indicated that in solid B_2O_3 an ordered layer formation takes place from single and double atomic layers. In molten B_2O_3 distorted single layers occur, together with irregular deposits of BO_3 groups in the form of networks; these deposits are more extensive at the higher temperature. B.T.M.Willis
- 539.213
6295. STRUCTURE OF PRECIPITATED AMORPHOUS ARSENIC AT VARIOUS TEMPERATURES. H.Richter and G.Gommel. Z. Naturforsch., Vol. 12a, No. 12, 996-1002 (1957). In German.
 Successful photographs were obtained not only with $Cu K\alpha$, but also with $Mo K\alpha$ and with filtered Ag radiation. Atom distribution curves obtained with the latter two radiations showed a greater differentiation than those obtained previously with $Cu K\alpha$. According to these results freshly precipitated amorphous As has layer aggregates of ~15 Å with $r_{K_1} \approx 3.80$ Å as shortest layer spacing (the lattice value being $r_{K_1} = 3.15$ Å). The layer aggregates are connected with one another by transition regions with very irregular atom distribution. When the amorphous As preparations were annealed for several hours at 250°C (below the transformation temperature $T_U = 285^\circ\text{C}$), the normal crystalline As appeared, although only in space elements of ~8 Å. F.Lachman
- 539.213 : 532.74
6296. STRUCTURE OF SOLID AMORPHOUS AND MOLTEN SELENIUM IN THE TEMPERATURE RANGE -180 TO 430°C. H.Richter and F.Herre. Z. Naturforsch., Vol. 13a, No. 10, 874-85 (Oct., 1958). In German.
 Amorphous Se, condensed from the vapour at liquid air temperature, has a layer structure consisting of Se_8 rings, as shown by X-ray measurements. This structure largely persists after warming to room temperature. Se layers prepared at room temperature are of a mixed phase composed of the normal Se lattice, an extended Se lattice and ordered folded Se rings. The composition depends on the method of preparation. Measurements at temperatures between 225 and 430°C showed that molten Se has a similar mixed composition. J.Franks
- 539.213
6297. STRUCTURE OF AMORPHOUS GERMANIUM AND SILICON. H.Richter and G.Breitling. Z. Naturforsch., Vol. 13a, No. 11, 988-96 (Nov., 1958). In German.
 Scattering curves were obtained with Cu, Mo and Ag radiations and radial distributions of atoms deduced. These indicate the existence in both Ge and Si of packets of (111) layers of thickness 15 Å, with disordered regions between them. A.R.Stokes
- 539.213
6298. DENSITY FORMULA FOR ALKALI SILICATE GLASSES FROM ANNEALING TO GLASS-PROCESSING TEMPERATURES. L.W.Tilton. J. Res. Nat. Bur. Stand., Vol. 61, No. 6, 463-7 (Dec., 1958).
 An additive formula is given for the computation of specific volumes of molten and compacted alkali silicate binary glasses with modifiers up to 50 mole per cent and from annealing temperatures (400° or 500°C) to 1400°C. The effective partial volumes v_g for the silica are postulated as

$$(1/v_g) = 2.198 + r_m C_g (1723 - t),$$
 where r_m is the mole fraction of nonsilica and C_g is a constant to be evaluated from glass-density data. This is based on the idea that silica networks can contract in volume as temperatures are lowered provided, and in proportion as, modifier ions are present in the glass. The effective partial volumes of R_2O , the nonsilica, are assumed as linear functions of temperature but not of the fraction of silica present. Computed and observed densities agree within approximately 1%. The effective volumes of nonsilica are somewhat smaller than published estimates for the oxides themselves, as should be expected because of interpenetrations.
- 539.213
6299. PROPERTIES OF ZINC BOROSILICATE GLASSES. E.H.Hamilton, R.M.Waxler and J.M.Nivert, Jr. J. Res. Nat. Bur. Stand., Vol. 62, No. 2, 59-62 (Feb., 1959).
 The glass-forming region of the system $ZnO-B_2O_3-SiO_2$ was surveyed. Glasses were made with compositions within the following limits in mole percent: 50 to 62.5 ZnO , 20 to 43.5 B_2O_3 , and 0 to 20 SiO_2 . They can be melted and poured below 1400°C. The glasses have low coefficients of thermal expansion, high values of elastic moduli and Poisson's ratio, and refractive indices from 1.6409 to 1.6798.
- 539.213.2 : 535.323
6300. PROPERTIES OF SODIUM TITANIUM SILICATE GLASSES. E.H.Hamilton and G.W.Cleek. J. Res. Nat. Bur. Stand., Vol. 61, No. 2, 89-94 (Aug., 1958).
 The glass-forming area of $Na_2O-TiO_2-SiO_2$ system was surveyed. Glasses were made with refractive indices from 1.5184 to 1.8005, ν -values from 51.5 to 23.2, and densities from 2.42 to 3.00. The glasses have higher dispersions and have considerably lower densities than the PbO glasses with comparable refractive indices.
- 539.215 : 538.221
6301. ON THE DETERMINATION OF PARTICLE SIZE IN HIGHLY DISPERSED IRON AND COBALT FROM MAGNETIC MEASUREMENTS. W.Hennig and E.Vogt. Z. Naturforsch., Vol. 12a, No. 9, 754-5 (1957). In German.
 An outline is given of how the size distribution of small ferromagnetic particles can be deduced from the variation of remanent magnetization with temperature. Applied to Co-amalgam, the method shows that with increasing ageing the small Co particles fuse to form larger ones. Measurements on Fe-amalgam produced somewhat different results from those of Bean and Jacobs (Abstr. 4794/1957). R.C.Kell
- 539.215.08 : 537.531
PARTICLE SIZE DETERMINATION BY SMALL ANGLE X-RAY SCATTERING. See Abstr. 5786

539.217 : 539.32
 6302. INVESTIGATION OF INTERNAL ADSORPTION OF CARBON IN α -IRON BY THE STUDY OF INTERNAL FRICTION. Yun' Pao-tsu and Ke Tun-sui. Fiz. Metallov i Metallovedenie, Vol. 4, No. 3, 407-16 (1957). In Russian.

Translated from English by V.I. Arkharov. First published in Chinese in Acta Physica Sinica, Vol. 12, No. 6, 1956.

539.217
 6303. DIFFUSION IN METALS. P. Shewmon. Industr. engng Chem., Vol. 51, No. 3(II), 402-5 (March, 1959).

Recent experimental and theoretical research is reviewed. A bibliography is presented containing 106 items (covering 1957-58) grouped under the following headings: Alloy diffusion; Diffusion in pure metals; Off-diagonal terms; Diffusion in liquids; Diffusion of interstitials; Diffusion along surfaces.

539.217
 6304. DYNAMICAL THEORY OF DIFFUSION IN CRYSTALS. S.A. Rice. Phys. Rev., Vol. 112, No. 3, 804-11 (Nov. 1, 1958).

The theory of self-diffusion in a crystal via the vacancy mechanism is studied from a detailed dynamic model. It is shown that the parameters which determine the diffusion coefficient can be defined in terms of the normal coordinates of the crystal. The effects of lattice imperfections are considered explicitly in the formulation in the normal mode analysis, but no detailed analysis is given. The effects of the correlation in motion of atoms is considered and some comments on the physical nature of the contributions to the enthalpy and entropy of activation are presented.

539.217
 6305. DIFFUSION OF PHOSPHORUS INTO SILICON UNDER CONDITIONS OF CONTROLLED VAPOUR PRESSURE. M.J. Coupland. Proc. Phys. Soc., Vol. 73, Pt 4, 577-84 (April, 1959).

The diffusion of phosphorus into silicon was studied and a relationship between the surface concentration of phosphorus and the vapour pressure of the phosphorus ambient is presented. It is shown that control of the surface concentration over the range 3×10^{15} atoms/cm³ to 5×10^{18} atoms/cm³ has been achieved. Factors setting the limits to the range are discussed and a method of raising the upper limit to 10^{20} atoms/cm³ is indicated. The results are discussed in relation to the theory presented by Smits and Miller.

539.217
 6306. CORRELATION FACTORS FOR DIFFUSION IN SOLIDS. II. INDIRECT INTERSTITIAL MECHANISM. K. Compagnon and Y. Haven. Trans. Faraday Soc., Vol. 54, Pt 10, 1498-508 (Oct., 1958).

For Pt I, see Abstr. 1671 (1957). The relation between diffusivity and conductivity of ions in ionic crystals is given by a relation of the type $D = f kT/Ne^2$. In this paper the value of f has been calculated for the indirect interstitial mechanism of transport in a few types of ionic crystals. The method of calculation has been described.

539.217
 6307. SELF-DIFFUSION AND HETERODIFFUSION IN HETEROGENEOUS POROUS BODIES. II. THE DIRECT AND THE REVERSE FRENKEL EFFECT. B. Ya. Pines and A. F. Sirenko. Zh. tekh. Fiz., Vol. 28, No. 8, 1748-52 (1958). In Russian.

In the first part, published in the same journal, Vol. 23, No. 9, 1559 (1953), and abstracted in Referativnyi Zhurnal Fizika, No. 21797 (1955), the authors described their experiments on the sintering of heterogeneous porous bodies consisting of very closely arranged Cu and Ni wires; they found that a preferential heterodiffusion (Cu into Ni) took place, while "fine porosity" appeared in the component (Cu) which supplied the diffusing atoms; these phenomena did not depend on the mutual arrangement of the wires or on the kind of atmosphere (N₂ or vacuum). The arising of porosity was explained on the basis of Frenkel's theory according to which the diffusion (and self-diffusion) takes place owing to the atoms' filling the vacancies in the crystal lattice. In the present paper the authors contend that the so-called Kirkendall effect (Smigelskas and Kirkendall, American Institute of Mining and Metallurgical Engineers, Tech. Publ. 2071/1946) does not predetermine the phenomenon of additional porosity on diffusion; since this porosity arises as a result of the vacancy mechanism suggested by Frenkel, it should be called the Frenkel effect. This effect should be treated as the manifestation of "vacancy self-diffusion" (diffusion of vacancies) caused by the inequality of the partial coefficients of heterodiffusion. It is deduced

theoretically that, besides the direct Frenkel effect, there should be possible the reverse effect, viz. the arising of concentration heterogeneity (by ascending diffusion) in the case of a non-uniform partial self-diffusion in an alloy. This reverse effect was established experimentally during the sintering of specimens obtained by the compression of Cu-Ni, Fe-Ni and α -brass grains. F. Lachman

539.217.1 : 538.2
 DEPENDENCE OF THE MAGNETIC PROPERTIES OF SINTERED PERMANENT MAGNETS ON POROSITY. See Abstr. 5893

539.23 : 538.2
 MAGNETIC PROPERTIES OF THIN ELECTROLYTICALLY DEPOSITED AND EVAPORATED NICKEL AND IRON FILMS. See Abstr. 5888-9

539.23 : 538.2
 MAGNETIC INVESTIGATIONS ON ELECTROLYTICALLY DEPOSITED THIN COBALT FILMS. See Abstr. 5890

539.231 : 548.2
 CRYSTAL GROWTH ON CATHODE SPUTTERED COPPER FILMS BY PAIRS OF DOUBLE SPIRAL MECHANISMS ANALOGOUS TO FRANK-READ SOURCES. See Abstr. 5242

539.234 : 535.3
 6308. OPTICAL PROPERTIES OF VARIOUS EVAPORATED RARE EARTH OXIDES AND FLUORIDES. G. Hass, J. B. Ramsey and R. Thun. J. Opt. Soc. Amer., Vol. 49, No. 2, 116-20 (Feb., 1959).

To furnish a greater choice of film materials for application in optical multilayer coatings, the optical properties of evaporated rare earth compounds such as Y₂O₃, La₂O₃, Pr₆O₁₁, Nd₂O₃, Sm₂O₃, Gd₂O₃, LaF₃, NdF₃, and CeF₃ were studied in the wavelength region from 0.22 micron to 2 microns. The materials were evaporated from tungsten boats and condensed on glass and fused quartz substrates at various temperatures. The optical constants n and k were determined mainly from reflectance, transmittance, and true thickness measurements. The following oxides were found to be useful because of their low absorption in the visible: La₂O₃ with n ranging from 1.85 to 1.95 with increasing thickness, Pr₆O₁₁ with n ranging from 1.92 to 2.05, also with increasing thickness, and Nd₂O₃ with $n = 2.05$ for films of sufficiently low absorption. LaF₃ ($n = 1.60$) and NdF₃ ($n = 1.61$) showed no appreciable absorption in the whole wavelength region studied; CeF₃ ($n = 1.63$), however, exhibited two weak absorption bands at 0.234 and 0.248 microns. All n -values are given at a wavelength of 0.5 micron and for unbaked films deposited at 300°C substrate temperature. The oxides condensed as almost amorphous films, whereas the fluorides developed fairly large grains as indicated by their sharp electron diffraction rings. All films were hard and showed excellent chemical and mechanical durability.

539.234
 6309. THE OPTICAL PROPERTIES OF EVAPORATED CHROMIUM FILMS. R. M. Hill and C. Weaver. Trans. Faraday Soc., Vol. 54, Pt 10, 1464-76 (Oct., 1958).

The structures of very thin, vacuum-evaporated, films of chromium are investigated by optical methods. The optical constants for a series of films of varying thicknesses are calculated from reflectivity and transmission measurements, and the films are found to be inhomogeneous. The changes in the optical constants with thickness are found to be inconsistent with either the Maxwell-Garnett theory of spherical particles or with Schopper's theory of ellipsoidal aggregates. It is suggested that the anomalous refractive index values are due to the presence of a very thin layer of oxide around each individual metal particle. Assuming that the particles have an ellipsoid shape, results are obtained which agree with the experimental values. It is found that the thickest film can be considered as consisting of two separate layers of different refractive indices, the surface layer exhibiting bulk optical properties, and the first deposited layer having the optical properties of the metal and oxide particles described above.

539.234
 6310. ELECTRON OPTICAL INVESTIGATION OF THE STRUCTURE OF EVAPORATED FILMS OF InSb. L. Reimer. Z. Naturforsch., Vol. 13a, No. 2, 148-52 (Feb., 1958). In German.

The structure and composition of thin films (500 Å) of indium antimonide were investigated by electron diffraction and microscopy in transmission, the films being prepared on substrates at various temperatures. To obtain a film of truly stoichiometric composition

and with reasonably large crystal size, the temperature must be maintained at 400°C or higher. Deposition at room temperature, followed by annealing, gives very poor films. Thicker films, of about 1 μ , were investigated by the replica method and the same dependence of structure on temperature of deposition was found. The Hall effect and the change of resistance in a magnetic field were measured for the thick films, and were consistent with a purity of 99.995%.

V.E.Cosslett

539.234

6311. X-RAY INVESTIGATION OF EVAPORATED Bi LAYERS AT LOW TEMPERATURES. H.J.Queisser. Z. Phys., Vol. 152, No. 4, 495-506 (1958). In German.

Bi layers, containing various additions (LiF, RbI, Cu and Sb) were condensed from the vapour at the temperature of liquid H₂ and their structures studied by X-rays, both as laid down and after heating. It was found that the structure as laid down was "disordered", i.e. that diffuse X-ray reflections were obtained. On heating, the reflections became sharp. The additives in every case were found to stabilize the "disordered" structure.

J.Thewlis

539.234

6312. DISSOCIATIVE ADSORPTION OF METHANE AND ETHANE ON EVAPORATED METAL FILMS.

P.G.Wright, P.G.Ashmore and C.Kemball.

Trans Faraday Soc., Vol. 54, Pt 11, 1692-702 (Nov., 1958).

The adsorption of methane and ethane on evaporated metal films was investigated. Observations were made at 0-100°C for both gases on tungsten and for ethane on nickel; for these systems the initial adsorption required no activation energy. Higher temperatures were necessary to adsorb methane on nickel (140°) and iron (170°) and ethane on iron (70°), because the initial adsorptions required activation. The adsorption of the hydrocarbons usually led to the formation of gaseous hydrogen especially at the higher temperatures. Analysis of the gas phase by means of a Pirani gauge enabled the gross composition of the adsorbed phase to be determined as CH₄ or C₂H₆. In some cases remarkably low values of n were observed after about 3 hr. Typical compositions were CH₂ at 100°C and C₂H₂ at 90°C on tungsten, CH_{0.1} on nickel and CH₂ on iron at 200°C. The rate of liberation of hydrogen to the gas phase was followed and activation energies for this process determined. The rate-determining step appeared to be the breakdown of the adsorbed radicals and not the desorption of hydrogen.

539.234 : 531.717

6313. ON THE MEASUREMENT WITH AN IONIZATION GAUGE OF THE DENSITY IN A VAPOUR STREAM FOR THE PRODUCTION OF THIN FILMS ON A SUBSTRATE. O.Haase.

Z. Naturforsch., Vol. 12a, No. 11, 941-2 (1957). In German.

Description of a method for the measurement of the thickness of films condensed from the vapour phase, even when these films are too thin to be accessible to multiple beam interferometry.

R.Schnurmann

539.234

6314. SOME PROPERTIES OF THIN MONOCRYSTALLINE FILMS OF BARIUM-STRONTIUM TITANATE PRODUCED BY VACUUM EVAPORATION IN AN ELECTRIC FIELD. A.Moll. Z. angew. Phys., Vol. 10, No. 9, 410-16 (Sept., 1958). In German.

The films, of thickness up to several microns, were produced by a form of flash evaporation of (Ba/Sr)TiO₃ mixtures, the substrate being held at temperatures between 100 and 200°C. The electric field is said to promote growth of single crystal layers. Permittivities at microwaves of 15 to 30 cm length were measured for film thicknesses between 0.1 and 1.6 microns. The thinnest films had permittivities of 6000 to 8000, while the thicker films showed lower values which decreased further at shorter wavelengths and showed some long-term instability. These thicker films are thought to contain imperfections which lead to unfavourable domain-structures. Breakdown strength was also measured, using evaporated counter-electrodes, the highest value being 0.5 MV/cm.

K.W.Plessner

539.234 : 538.2

DEPENDENCE OF GEOMETRIC MAGNETIC ANISOTROPY IN THIN IRON FILMS. See Abstr. 5877

ELASTICITY . STRENGTH . RHEOLOGY

539.31

6315. RESIDUAL TENSIONS IN METALS; THEIR DETERMINATION. I. GENERALITIES. METHODS OF DETERMINATION. J.M.Sistiaga.

Rev. Cienc. apl., Vol. 12, No. 5, 385-96 (Sept.-Oct., 1958).

In Spanish.

539.31

6316. RESIDUAL TENSIONS IN METALS; THEIR DETERMINATION. II. METHODS OF DETERMINATION (CONTINUED). CONCLUSIONS. J.M.Sistiaga.

Rev. Cienc. apl., Vol. 12, No. 6, 496-507 (Nov.-Dec., 1958).

In Spanish.

An extensive critical review. 115 references.

L.Pincherle

539.31 : 534.23

RELAXATION PROCESS IN BISMUTH. See Abstr. 5458

539.319 : 539.17

6317. THERMAL STRESSES IN A LONG CYLINDRICAL FUEL ELEMENT, WITHOUT CANNING, DURING HEATING. W.Kattwinkel. Atomkernenergie, Vol. 3, No. 10, 394-6 (Oct., 1958). In German.

Stress distribution is calculated. The maximum stresses appear, in the steady state, at the surface of the element, where $\sigma_\theta(R) = \sigma_z(R)$ and both of them are tensile stresses. These conditions are fulfilled also in the non-steady state of temperature distribution.

539.31 : 541.6

6318. THE CORRELATION OF INTERNAL FRICTION AND CHEMICAL STRUCTURE IN ORGANIC GLASSES.

J.J.Benbow and D.J.C.Wood.

Trans. Faraday Soc., Vol. 54, Pt 10, 1581-7 (Oct., 1958).

The internal friction of a number of organic glasses was measured over a wide range of frequency. At the lower frequencies, the glasses are distinguished from one another by the extent to which the dependence of the internal friction on frequency conforms to the theoretical predictions for a Maxwell body. The frequency range over which this conformity is observed can be linked qualitatively with the effective size of the glass molecules, taking into account the existence of intermolecular association. At high frequencies, the internal friction of each glass tends towards a definite, frequency-independent, value; the magnitude of these values, when adjusted for the different viscosity characteristics of the glasses, can be correlated with the estimated degree of flexibility of the molecules involved. These conclusions apply to the internal friction behaviour of high polymers. It is pointed out that the internal friction of a wide variety of materials, under conditions where no appreciable viscous flow occurs, exhibits a frequency-independent component.

539.32

6319. INTERNAL FRICTION IN DEFORMED Al-Mg ALLOYS.

A.V.Grin' and V.A.Pavlov.

Fiz. Metallov i Metallovedenie, Vol. 4, No. 1 (10), 103-11 (1957).

In Russian.

539.32

6320. STRESS-STRAIN PROPERTIES OF IRRADIATED FILLED NATURAL RUBBER. S.H.Pinner.

Internat. J. appl. Radiation and Isotopes, Vol. 5, No. 2, 121-34 (March, 1959).

The stress-strain behaviour of carbon-black filled natural rubbers, cured by exposure to 1 MeV electrons, was examined in relation to that of normal vulcanizates. A simple empirical power law relating modulus to elongation has facilitated handling of the experimental data. Antioxidants and other normal ingredients of the rubber mix confer improved ageing resistance but also increase the radiation dose required for a given modulus. Comparing radiation and sulphur cure, the former gives products adequate in modulus and ageing resistance but inferior in ultimate elongation for a given modulus and in tensile product. Special formulation may lead to improved products.

539.32
6321. ELASTIC CONSTANTS OF THORIUM SINGLE CRYSTALS IN THE RANGE 77-400°K. P.E.Armstrong, O.N.Carlson and J.F.Smith. J. appl. Phys., Vol. 30, No. 1, 36-41 (Jan., 1959).

The elastic constants of thorium single crystals were determined at ultrasonic frequencies employing both resonance and pulse-echo techniques. The values at 300°K in units of 10^{11} dyne/cm² are, $C_{11} = 7.53$, $C_{12} = 4.89$, and $C_{44} = 4.78$. The constants C_{11} and C_{44} increase and C_{12} decreases with decreasing temperature and extrapolate to 7.79, 4.82, and 5.13, respectively at 0°K. The Cauchy relation $C_{12} = C_{44}$ occurs, quite probably fortuitously, at 271°K. The anisotropy factor $2C_{44}/(C_{11} - C_{44})$ at room temperature is 3.6 which is comparable to the values for lead and gold. Calculated Poisson's ratios, σ_{100} and σ_{111} , indicate a much stronger resistance to contraction in the close-packed planes than in the less densely packed (100) planes.

539.32
6322. MEASUREMENT OF THE ELASTIC CONSTANTS OF CdS SINGLE CRYSTALS. E.Gutsche. Naturwissenschaften, Vol. 45, No. 23, 566 (1958). In German.

The elastic constants were determined at room temperature from measurements of static torsion, static bending and compressibility. The results showed that CdS (with the hexagonal wurtzite structure) behaves approximately as an isotropic elastic medium.

B.T.M.Willis

539.32
6323. SOME ELASTIC PROPERTIES OF HEXAGONAL CADMIUM SULPHIDE CRYSTALS. H.Gobrecht and A.Bartschat. Z. Phys., Vol. 152, No. 4, 417-24 (1958). In German.

Shear vibrations in the thickness mode were generated in single crystals of cadmium sulphide, the tests covering the frequency range from 0.1 to 7.0 Mc/s. When n is the order of the harmonic, f_n the corresponding frequency of vibration, c' the effective modulus of elasticity, ρ the density of the material and D the thickness of the crystal, $f_n = (n/2D)(c'/\rho)^{1/2} = nN/D$ where $N = \frac{1}{2}(c'/\rho)^{1/2}$ and is called the vibrational coefficient. The value of N approaches asymptotically to a constant value as the width/thickness ratio of the specimen approaches to about 10 and, for this reason, all the crystals used had an edge/thickness ratio exceeding 10. The thicknesses tested ranged from 0.1 to 0.7 mm, and the fundamental frequency f_1 decreased with increase of thickness according to a relation $f_1 = N/D$ and $N = 0.89 \times 10^6$ c/s per cm. Corresponding values for EDT are $0.923-0.925 \times 10^6$, for DKT $1.055-1.070 \times 10^6$, and for quartz $1.660-2.541 \times 10^6$. The elastic modulus of CdS was found to be 1.53×10^{11} dynes/cm². The temperature coefficient of the resonant frequency was found to be negative for the range from +20 to -180°C, the increase in resonant frequency for this range of temperature being about 1% regardless of frequency itself.

A.C.Whiffin

539.32 : 539.217
INVESTIGATION OF INTERNAL ADSORPTION OF CARBON IN α -IRON BY THE STUDY OF INTERNAL FRICTION. See Abstr. 6302

539.37 : 534.22
EFFECT OF STATICALLY APPLIED STRESSES ON THE VELOCITY OF PROPAGATION OF ULTRASONIC WAVES. See Abstr. 5439

539.371
6324. THERMOELASTIC PHENOMENA IN RUBBERS BASED ON NATURAL LATEX DURING CYCLIC DEFORMATION. M.P.Votinov, L.L.Sul'zhenko and E.V.Kuvshinskiĭ. Zh. tekhn. Fiz., Vol. 27, No. 10, 2307-13 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 10, 2143-8 (Oct., 1957).

Investigated in extension-contraction cycles. The deformation rate was 100% per sec. The rubbers differed in vulcanization conditions and in the nature of the dispersed filler. Heat, equivalent to the work of extension, is shown to be generated in the first stages of extension. Further deformation causes excess heat (related to crystallization) to be generated reversibly. The onset of crystallization depends on the vulcanization conditions and on nature of the dispersed filler.

539.371
6325. LAWS GOVERNING THE CONVERSION OF WORK INTO HEAT IN THE ADIABATIC DEFORMATION OF BUTYL RUBBER VULCANIZATES. M.P.Votinov and E.V.Kuvshinskiĭ. Zh. tekhn. Fiz., Vol. 27, No. 11, 2554-6 (1957). In Russian. English translation in Soviet Physics — Technical Physics (New York), Vol. 2, No. 11, 2375-7 (Nov., 1957).

The thermoelastic properties were studied by the adiabatic extension method. It is shown that crystallization in unfilled vulcanizates begins at extensions $\lambda > 7$. Vulcanizates containing gas black (60 parts by weight) do not crystallize at deformations up to $\lambda \approx 9.6$. The initial stages of deformation are accompanied by cooling of the vulcanizates, by as much as 1 deg C.

539.373
6326. THE SLIP THEORY OF PLASTICITY FOR CRYSTALLINE AGGREGATES. H.Payne. J. Mech. Phys. Solids, Vol. 7, No. 2, 126-34 (March, 1959).

The model for predicting the plastic behaviour of a crystalline aggregate under uniaxial stress from empirical data on slip in the single crystal which has been developed by Taylor (1938) and modified by Bishop and Hill, and by Lin is presented in a mathematical form which provides for the case in which the stress is not uniaxial.

539.374
6327. THE MECHANISM OF PLASTIC DEFORMATION AND MECHANICAL PROPERTIES OF ALUMINIUM. I-II. É.S.Yakovleva. Fiz. Metallov i Metallovedenie, Vol. 4, No. 1 (10), 141-4, 145-50 (1957). In Russian.

539.374 : 534.2
6328. THE PROPAGATION OF DYNAMIC STRESSES IN VISCO-ELASTIC RODS. D.S.Berry and S.C.Hunter. J. Mech. Phys. Solids, Vol. 4, No. 2, 72-95 (Feb., 1956).

An account is given of the propagation when the ends of the rods satisfy a wide variety of boundary conditions. It is assumed that the material of the rods satisfies a stress-strain relation of either of the types

$$\epsilon(t) = \int_{-\infty}^t \chi(t-\tau) \frac{d\sigma(\tau)}{d\tau} d\tau, \quad \sigma(t) = \int_{-\infty}^t \phi(t-\tau) \frac{d\epsilon(\tau)}{d\tau} d\tau,$$

and that the strains are infinitesimal. General solutions of the equations of motion are derived by use of the theory of Laplace transforms and their applicability demonstrated by the consideration of special problems. The theory of possible experiments to determine the functions $\chi(t)$, $\phi(t)$ for any given material is also developed.

539.374
6329. ON THE DELAY TIME IN PLASTIC FLOW OF INDIUM ANTIMONIDE. J.W.Allen. Phil. Mag. (Eighth Ser.), Vol. 3, 1297-305 (Nov., 1958).

The delay time before the onset of plastic deformation has been studied as a function of temperature and stress for indium antimonide in uniaxial compression. The temperature range was 150-350°C, and the stresses were about 10^6-10^7 dynes/cm². An empirical relation of the form $\tau = \text{const.} \sigma^{-n} T \exp(E/kT)$ has been found. A theory of dislocation production is advanced to explain these results.

539.374
6330. MECHANICAL WORK IN PLASTIC PROCESSES. G.Rieder. Z. angew. Phys., Vol. 10, No. 3, 140-50 (March, 1958). In German.

A mathematical discussion of the forces on lattice disturbances that are capable of migrating, including the derivation of general formulae (expressed in terms of volume integrals) for the virtual work associated with variations of elastic properties and plastic distortion.

J.G.Oldroyd

539.382
6331. THE STRAIN-RATE SENSITIVITY OF α -URANIUM. C.J.Maiden. J. Mech. Phys. Solids, Vol. 7, No. 2, 106-13 (March, 1959).

Experiments are described in which specimens from two different batches of uranium were subjected to both static and dynamic compression tests. From such tests static and dynamic stress-strain curves were obtained. These stress-strain curves indicate that α -uranium is slightly strain-rate sensitive; for

instance, the effect of increasing the strain rate from 2.5×10^{-3} per sec to several hundred per sec was to raise the stress, at any strain less than about 4%, by approximately 10%. After about 4% strain the strain-rate sensitivity was found to decrease with increased deformation. In order to determine the variation in dynamic strength of α -uranium with test temperature, as-cast specimens from the first batch of uranium were tested dynamically at -41°C and -84°C . The results obtained indicate that the rate of increase of strength with decreasing temperature is small, the effect of lowering the test temperature to -84°C being to raise the dynamic stress-strain curve corresponding to given test conditions by only about 5%. Also, to determine the effect of grain size on the dynamic strength of uranium, tests were made on the first batch of uranium in the β -quenched state. It was found that, for identical test conditions, the derived dynamic stress-strain curve for the β -quenched material was approximately 10% higher than for the as-cast material. The second batch of uranium was also tested dynamically in the 300°C rolled condition. The results of such tests indicate that the dynamic compressive strength of 300°C rolled uranium, in the direction of rolling, is slightly greater than the dynamic compressive strength of α -uranium in the as-cast state.

539.386 : 539.21

IRRADIATION EFFECTS ON CRITICAL SHEAR STRESS IN METALS. See Abstr. 6293

539.388.1

6332. DYNAMIC FATIGUE OF GLASS. R.J.Charles. J. appl. Phys., Vol. 29, No. 12, 1657-62 (Dec., 1958).

An analytical model, which is applicable to static fatigue of lime glass, was extended to account for dynamic fatigue of the same glass. The model successfully predicts the room temperature strain rate sensitivity of the failure process in lime glass and indicates a method by which the stress concentration relationship, applicable to microscopic flaws on glass surfaces, may be obtained by experiment. Resulting experiments showed that the stress concentration relationship proposed by English is valid.

539.389.1

6333. THE TORSIONAL YIELD STRESS OF ZINC SINGLE CRYSTALS. N.Brown and H.S.Rosenbaum. J. Mech. Phys. Solids, Vol. 7, No. 2, 97-105 (March, 1959).

The yield stress of circular cylindrical zinc crystals was measured both in torsion and in either shear or tension. Both type of tests were made on the same specimen. The yield stress in torsion varied with the angle between the basal plane and the axis of torsion. When the normal to the basal plane coincides with the axis of torsion, the maximum shear stress in torsion as calculated by the theory of elasticity was found to be 1.6 ± 0.1 times the critical resolved shear stress as measured by tension or shear. This value is greater than that found by previous investigators. If it is assumed that the specimen has slipped almost entirely over its cross-section at the macroscopic yield point, then the average stress sustained by the crystal is 1.24 times the critical resolved shear stress.

539.389.1

6334. INFLUENCE ON CHARACTERISTIC YIELD POINT OF MILD STEEL BY SANDBLASTING. H.Spindler. Naturwissenschaften, Vol. 45, No. 23, 566-7 (1958). In German.

Stress-strain curves obtained before and after sandblasting mild steel sheet of different thicknesses showed that the characteristic yield point "kink" was completely suppressed by sandblasting sheet 1 mm thick, and was barely noticeable in sheet 3 mm thick. For sheet of 5 or 8 mm thickness, sandblasting made no perceptible difference to the curves. Some tentative explanations are offered.

H.J.H.Starks

539.389.3

6335. ORIGIN OF RELAXATION PROCESSES IN SOLIDS. R.Kamel. Proc. Math. Phys. Soc. Egypt, No. 21, 33-40 (May, 1957).

The anelasticity of solids is discussed in the light of relaxation phenomena occurring as a result of the experimental conditions or the constitution of the specimen. Four types of relaxation processes were investigated, namely, diffusion of transverse thermo-elastic currents, inter-grain diffusion in pure metals, atomic diffusion in both dilute and super-saturated solid solutions, and ionic diffusion in glass. The temperature dependence of the time of relaxation, τ , for each relaxation process was calculated from the author's previously published data. The energies activating these processes were measured from the slopes of the corresponding lines in the log τ versus $1/T$ plot (T being the absolute temperature).

539.434

6336. ACTIVATION ENERGIES FOR HIGH TEMPERATURE CREEP OF POLYCRYSTALLINE ZINC. W.J.M.Tegart and O.D.Sherby.

Phil. Mag. (Eighth Ser.), Vol. 3, 1287-96 (Nov., 1958).

The creep of polycrystalline zinc above $0.5 T_m$ (T_m = absolute melting temperature) appears to be controlled by two thermally activated processes acting additively. One process, predominating between 0.5 and $0.6 T_m$, is believed to be associated with dislocation climb since the experimentally determined activation energy for creep is about equal to the energy for self-diffusion, namely, about 21.0 kcal per mole. The other process, predominating between 0.8 and $1.0 T_m$, is believed to be associated with prismatic slip since the activation energies for these two processes are both equal to about 38.0 kcal per mole.

539.531 : 539.21

HARDNESS CHANGES IN ALKALI HALIDE SINGLE CRYSTALS PRODUCED BY DEUTERON BOMBARDMENT. See Abstr. 6292

539.87 : 541.135.5

EFFECT OF TORSIONAL STRESS ON THE ELECTRODE POTENTIAL OF COPPER. See Abstr. 5224

539.89 : 534.222.2

SHOCK-WAVE COMPRESSION OF ALUMINIUM. See Abstr. 5445

PHYSICAL CHEMISTRY

PHASE EQUILIBRIUM
CHEMICAL REACTIONS

541.122 : 539.19

6337. INTERPRETATION OF CHAIN-RING EQUILIBRIA IN THE
POLYMERIZATION OF SUBSTITUTED ϵ -CAPROLACTAM.

H.Yumoto.

J. chem. Phys., Vol. 29, No. 6, 1234-9 (Dec., 1958).

If one of the hydrogens in ϵ -caprolactam is substituted by a methyl or an ethyl group, the quantity of the lactam monomer remaining in its polymerization reaction is greater than that for the unsubstituted one. When the alkyl groups higher than ethyl are introduced, the lactam ring can hardly be polymerized. These shifts in chain-ring equilibria are explained by the change in the thermodynamical properties caused by the existence of rotational isomers. The heat of reaction and the quantity of the remaining lactam ring at the equilibrium for α -, β -, γ -, δ -, and ϵ -monomethyl and γ -ethyl derivatives were estimated from this point of view. The calculated and the observed values are in good agreement.

541.122.4

6338. COMPOSITION OF NITROGEN OXIDE EQUILIBRIA.

E.van Beek-Visser.

J. chem. Phys., Vol. 29, No. 6, 1358-60 (Dec., 1958).

The equilibrium is recalculated on the basis of the new spectroscopic value for the dissociation energy of nitrogen. Complete tables of the composition are given in the temperature range 2-5000°K. The maximum amount of fixed nitrogen (at 1 atm pressure and a nitrogen-oxygen ratio as in natural air) is ~ 5 mole % and occurs at a temperature of $\sim 3500^\circ\text{K}$. The influence of the N/O ratio is indicated.

541.122.4 : 536.7

CHEMICAL EQUILIBRIUM AMONG MOLECULES, ATOMS, AND
ATOMIC IONS CONSIDERED AS CLUSTERS. See Abstr. 5640

541.123.5

6339. ION EXCHANGE KINETICS. A NONLINEAR DIFFUSION
PROBLEM. II. PARTICLE DIFFUSION CONTROLLED EXCHANGE
OF UNIVALENT AND BIVALENT IONS.

M.S.Plesset, F.Helfferich and J.N.Franklin.

J. chem. Phys., Vol. 29, No. 5, 1064-9 (Nov., 1958).

For earlier work, see Abstr. 908 (1959). The differential equation derived previously, which describes the particle diffusion controlled ion exchange between spherical beads of uniform size and a well-stirred solution, is solved numerically for the exchange of monovalent ions for bivalent ions, and of bivalent ions for monovalent ions. The approach is based on the Nernst-Planck equations of ionic motion. Numerical results for six different mobility ratios, obtained by use of a digital computer, are presented and discussed. An explicit equation approximating the numerical data is given.

541.124

6340. HIGH-SPEED COMPUTATIONS IN THE KINETICS OF
FREE-RADICAL DEGRADATION. I. RANDOM INITIATION.

R.Simha, L.A.Wall and J.Bram.

J. chem. Phys., Vol. 29, No. 4, 894-904 (Oct., 1958).

The theory of the free-radical degradation leads to large sets of difference-differential equations for the reacting species, which can be solved analytically for practical purposes only in the extremes of preponderant chain depropagation and random or terminal scission, respectively. Moreover, the equations are linearized by neglecting the variation of the steady-state radical concentration with degree of volatilization. Numerical solutions of the linearized set were obtained on the SEAC and the resulting zeroth and first moments of the distribution tabulated for the case of random initiation. Thus the rate of volatilization and the number-average degree of polymerization can be computed as functions of conversion. Initially monodisperse systems and a maximum chain length of 400 C atoms, which determines the size of the set, were assumed. In addition to the latter there are three parameters, viz., the average "zip" length, $(1/\epsilon-1)$, a transfer constant, σ , and the maximum size of vaporizing chain fragments. All of these were varied over a wide range so as to reproduce the wide spectrum of behaviour found experimentally. Where applicable, earlier analytical results were confirmed. The errors inherent in the linear approximation can be estimated and are

found not to affect the results significantly over a useful extent of reaction. For a certain range of parameters, "corresponding states" rules can be established and the results applied regardless of the absolute magnitude of the initial chain length. Depending on the parameter values, and hence on the molecular structure, the initial rates also exhibit wide variations in absolute magnitude and sensitivity to initial molecular weight. The kinetics in polystyrene and particularly poly- α -methyl styrene are discussed in the light of the theory. For the latter polymer, both the decrease in molecular weight; and the dependence of initial rates on the initial chain length lead to a consistent picture of a long average zip length, approximately 1.3×10^3 monomer units, combined with a random initiation. The upper limit for the initiation constant is $3.42 \times 10^{-6} \text{ sec}^{-1}$ at 272°C .

541.124 : 534.22

CHEMICAL REACTION PROGRESS BY ULTRASONIC MEASUREMENTS. See Abstr. 5441

541.127

6341. KINETICS AND MOLECULAR WEIGHT DISTRIBUTIONS
FOR UNSTEADY-STATE POLYMERIZATIONS INVOLVING TER-
MINATION BY CHAIN TRANSFER WITH THE MONOMER.

W.T.Kyner, J.R.M.Radok and M.Wales.

J. chem. Phys., Vol. 30, No. 2, 363-8 (Feb., 1959).

The formal unsteady-state kinetics of a polymerization reaction with first-order initiation and termination by chain transfer with the monomer are solved, and expressions are obtained for number and weight average degrees of polymerization and polymerization rate as a function of time. Gold's results (Abstr. 9157/1958) for the case of no termination are included as a special case. The qualitative description of the kinetics by a single partial differential equation is also outlined.

541.127

6342. THEORETICAL PRE-EXPONENTIAL RATE FACTORS
FOR ABSTRACTION REACTIONS. O.Sinanoglu and K.S.Pitzer.

J. chem. Phys., Vol. 30, No. 2, 422-7 (Feb., 1959).

Equations are derived for the pre-exponential rate factors of abstraction reactions. The activated complex is considered as made up of three rigid groups. Classical partition functions are used and it is shown that the use of classical methods gives a simple expression which requires only a knowledge of several force-constants and bond lengths; thus the need for detailed structural information on reactants and complex and for calculations of moments of inertia and vibrational frequencies is eliminated. It is shown that quantum corrections need not be considered in many cases, although if desired, they may be estimated from a graph provided. The method is applied to four hydrogen abstraction reactions and to the reaction, $\text{CCl}_3\text{Br} + \text{Br} = \text{CCl}_3 + \text{Br}_2$. Satisfactory agreement is obtained.

541.127

6343. THE KINETIC ISOTOPE EFFECT IN THE DE-
CARBOXYLATION OF 2,4-DIHYDROXYBENZOIC ACID IN D_2O
SOLUTION. A.V.Willi.

Z. Naturforsch., Vol. 13a, No. 11, 997-8 (Nov., 1958). In German.

The ratio of the velocity constants of the decarboxylation in light and heavy water respectively is found to be 6.3. It is calculated that the ratio of the constants (k_H^A/k_D^A) for acid catalysis is 1.7 and

concluded that the hydrogen ion exchange on the salicylate ion is the rate determining step in the decarboxylation.

W.Good

541.127.1

6344. INTERRELATIONS INVOLVING SOLUTIONS OF
EQUATIONS OF EQUALIZING PROCESSES AND OSCILLATING
PROCESSES. D.G.O'Sullivan.

J. chem. Phys., Vol. 29, No. 4, 689-96 (Oct., 1958).

Assessment of the velocity of a fast chemical reaction can be made by studying the way the reaction interferes with other rapid processes. Both equalizing processes, such as diffusion, and oscillating processes, such as the passage of sound waves, can be employed. Solution of the differential equations of these processes, under a variety of conditions, is a necessary part of the background investigation of these methods and is also of importance in the study of many other physical and chemical problems. This paper shows how a wide range of these solutions can easily be obtained

from simpler existing solutions. Among other results, complete resolutions of the "age equation"

$$\partial v(r,t)/\partial t = D(r) \cdot \nabla^2 v(r,t) + A(r,t) + B(t) \cdot v(r,t)$$

and the vibration equation

$$\partial^2 \xi(r,\tau)/\partial \tau^2 + b \partial \xi(r,\tau)/\partial \tau = \kappa(r) \cdot \nabla^2 \xi(r,\tau) + A(r,\tau) + B(r) \cdot \xi(r,\tau)$$

have been effected for arbitrary initial conditions and a range of important boundary conditions (including those of Dirichlet and Neumann as special cases).

ELECTROCHEMISTRY

541.13 : 537.224 : 621.357.035.2 : 621.317.335
CAPACITIES OF SOLID METAL-SOLUTION INTERFACES.

See Abstr. 5648

541.133

6345. SOLUTIONS OF METALS IN AMINE SOLVENTS. II. A CONDUCTANCE FUNCTION FOR DILUTE SOLUTIONS OF SODIUM IN LIQUID AMMONIA. E.C.Evers and P.W.Frank, Jr. J. chem. Phys., Vol. 30, No. 1, 61-4 (Jan., 1959).

A conductance function is derived which represents the experimental data for solutions of sodium in ammonia up to a concentration of approximately 0.04 N. The derivation is based on the mass action concept involving species described in models by Becker, Lindquist, and Alder, and by Deigen.

541.133.1

6346. TRANSPORT MEASUREMENTS FOR THE DETERMINATION OF MOBILITIES OF Li^3 , Li^7 AND Pb IN MOLTEN LiCl-PbCl_2 MIXTURES. A.Klemm and E.U.Monse.

Z. Naturforsch., Vol. 12a, No. 4, 319-34 (1957). In German.

It was found from conductivity measurements and from observations of movable boundaries at 650°C that, in the total range of mixtures, the mobility of Pb increases along with the concentration of LiCl , whereas at 20 equiv. -% of LiCl the mobility of Li attains a minimum value. Results of isotopic analysis show that the reduced relative mobility difference of Li isotopes is almost constant (≈ -0.14) between 100 and 20 equiv. -%, whereas below 20 equiv. -% it increases, reaching the value -0.27 at 5 equiv. -% LiCl . The paper includes a theory of movable boundaries and deals in general with the measurability of mobilities in molten mixtures.

F.Lachman

541.133.1

6347. THE MOBILITY OF NO_3 AND Cl IN A MOLTEN $\text{AgNO}_3\text{-AgCl}$ MIXTURE. E.U.Monse.

Z. Naturforsch., Vol. 12a, No. 6, 526-8 (1957). In German.

The mobility of the chlorine ion was found, contrary to existing results, to be greater than that of the nitrate ion. The apparatus is described.

W.Good

541.135.2

6348. ELECTROLYTIC TRANSPORT IN THE α -PHASE OF THE SYSTEM Ag-Zn . H.G.Feller, T.Heumann and H.Weber.

Z. Naturforsch., Vol. 13a, No. 2, 152-60 (Feb., 1958). In German.

The transport numbers between 500 and 560°C and at a current density of 4 to 6 amps per sq. mm are 6×10^{-7} and 3×10^{-7} g-ion per faraday for Ag and Zn respectively. Both components wander to the anode, and the transport is a function of the current density. A description of the apparatus and a discussion of the results are given.

W.Good

541.135.2 : 539.18

THE TEMPERATURE DEPENDENCE OF THE ISOTOPE EFFECT FOR THE ELECTROLYTIC MIGRATION OF CHLORINE IONS IN MOLTEN THALLIUM (1) CHLORIDE. See Abstr. 6167

PHOTOCHEMISTRY RADIATION CHEMISTRY

541.14

6349. FLASH PHOTOLYSIS IN A SINGLE TUBE SYSTEM. H.Schüler and E.Krimmel.

Z. Naturforsch., Vol. 12a, No. 6, 528-9 (1957). In German.

The tube contains both the reaction medium and, out of line at an appropriate distance, the electrodes required for the flash discharge. Mixed with the vapour or gas to be photolysed is argon at 1 atm pressure which, with a co-axial magnetic field, prevents electrons from the discharge from reaching and disturbing the photolysis taking place in the neighbouring region. Preliminary experiments with benzene and water confirm the feasibility of studying the photolysis induced by the u.v. limit of the discharge (subject to the absorption of the radiation by the inert gas) in this type of tube system.

W.Good

541.14 : 535.343

EFFECT OF RING SIZE ON THE PHOTOLYSIS OF CYCLIC ETHERS. See Abstr. 5518

541.14 : 539.19

6350. PHOTOLYSIS OF NITROMETHANE AND OF METHYL NITRITE IN AN ARGON MATRIX; INFRARED DETECTION OF NITROXYL, HNO . H.W.Brown and G.C.Pimentel.

J. chem. Phys., Vol. 29, No. 4, 883-8 (Oct., 1958).

The photolysis of nitromethane in solid argon at 20°K gives methyl nitrite. All other products can be explained in terms of the secondary photolysis of methyl nitrite. This work provides a definitive basis for segregating the vibrational frequencies of the cis and trans isomers of methyl nitrite. The primary products of photolysis of methyl nitrite under these conditions are formaldehyde and nitroxy, HNO . The identification of HNO , detected by its infrared spectrum for the first time, is confirmed by the band shifts occurring upon deuteration. The vibrational frequencies of HNO (1570 and 1110 cm^{-1}) and DNO (1560 and 822 cm^{-1}) correspond to a bent molecule with a double bond between the nitrogen and oxygen atoms, thus supporting the structure HNO over the possible arrangement HON . The bending force constant 0.67×10^{-11} dyne-cm, suggests that the HNO angle is near 110° , larger than the earlier estimate of 102° based on electronic spectra.

541.15 : 538.27

ELECTRON SPIN RESONANCE STUDIES OF IRRADIATED TEFLON: EFFECTS OF VARIOUS GASES. See Abstr. 5909

DISPERSIONS . COLLOIDS . ADSORPTION

541.18 : 532

6351. THE COLLOIDAL NATURE OF MIXTURES OF LIQUIDS NEAR THE CRITICAL SOLUTION POINT. I. M.Volmer.

Z. phys. Chem. (Leipzig), Vol. 206, No. 3-4, 181-93 (Feb., 1957). In German.

The case of two almost immiscible liquids is considered. The size distribution of colloidal particles is much narrower than the Maxwell distribution. For an interfacial tension of 0.18 dynes/cm at 25°C it should be possible to find with an ultramicroscope colloidal particles in the system water/isobutyric acid.

R.Schnurmann

541.18.043

6352. EXTENSION OF SEDIMENTATION VELOCITY THEORY TO MOLECULES OF INTERMEDIATE SIZES.

H.Fujita and V.J.MacCosham.

J. chem. Phys., Vol. 30, No. 1, 291-8 (Jan., 1959).

The solutions to the Lamm differential equation of the ultracentrifuge

trifuge, subject to the appropriate initial and boundary conditions, constitute the basis from which sedimentation experiments are evaluated. Recently, there has been much interest in the sedimentation behaviour of molecules of intermediate sizes. The sedimentation of such molecules is characterized by the fact that the significant change of the concentration distribution occurs close to the meniscus. In such cases an exact mathematical analysis is complex, but an approximate analysis is presented to provide some new information about the sedimentation process. It remains to be seen whether this analysis can be applied in an experimental way to determine the characteristic molecular quantities of such molecules.

541.182

6353. A METHOD FOR THE DETERMINATION OF THE DISTRIBUTION-FREQUENCY OF AXIAL RELATIONSHIPS IN DISPERSE SYSTEMS. D.Schulze.

Exper. Tech. der Phys., Vol. 5, No. 3, 128-32 (1957). In German.

A previously described method for the measurement of distribution frequencies in disperse systems is now extended in the light of statistics concerning axial relationships (form factors). The bases of calculation are collated and explained from a nomograph.

H.H.Hodgson

CHEMICAL ANALYSIS

545.8 : 523.51

6354. A NEW METHOD OF ESTIMATING SMALL URANIUM CONTENTS AND ITS APPLICATION TO THE URANIUM ANALYSIS

OF STONE METEORITES. K.H.Ebert, H.König and H.Wänke. Z. Naturforsch., Vol. 12a, No. 10, 763-5 (1957). In German.

The method uses the concentration of xenon-133 produced by fission of the uranium-235.

J.M.Hough

545.822

6355. PHOTOELECTRIC SPECTROCHEMICAL ANALYSIS FOR THE TRACE OF BORON IN GRAPHITE. Y.Urano. Sci. of Light (Tokyo), Vol. 6, No. 2, 49-57 (Aug., 1957).

Traces of boron in almost pure graphite were determined. The light source is an a.c. arc triggered by a Tesla coil. Using an arc line of carbon as the internal standard line, another arc line of carbon and the resonance line of boron are measured under the discharge condition that the intensity ratio of the above two lines of carbon is an appropriately chosen value. The working curve so obtained is nearly linear down to a boron content of 0.2 p.p.m., and the reproducibility of measurements is about 4% standard deviation. Various factors which influence the lower limit of determination are discussed.

545.822 : 535.34.07

CORRECTION FOR INSTRUMENTAL DRIFT IN FLAME PHOTOMETRY. See Abstr. 5496

545.827

6356. MASS SPECTROMETRIC INVESTIGATIONS OF HYDROCARBONS AT HIGH TEMPERATURE.

H.Ehrhardt and O.Osberghaus.

Z. Naturforsch., Vol. 13a, No. 1, 16-21 (Jan., 1958). In German.

The mass spectrum of nine saturated hydrocarbons with 5, 6, and 7 carbon atoms is investigated in the temperature range 100° to 900°C. The ionization of a residual noble gas is used as a standard. The formation of methane by catalytic cracking is also investigated at different temperatures.

A.E.I. Research Laboratory

CRYSTALLOGRAPHY

548.3 : 535.37

6357. DILATOMETRIC STUDIES OF THE SYSTEM $\text{NH}_4\text{Br}-\text{TlBr}$; A CONTRIBUTION TO THE PROBLEM OF THALLIUM ACTIVATED LUMINOUS ALKALI HALIDES. P.Brauer.

Z. Naturforsch., Vol. 13a, No. 5, 405-9 (May, 1958). In German.

The system $\text{NH}_4\text{Br}-\text{TlBr}$ was dilatometrically investigated with respect to the problem of how TlBr , which crystallizes in the CsCl -type, influences the crystallization of the system into the same type at low temperatures, but at high temperatures into the NaCl -type favoured by NH_4Br . It is found that NH_4Br and TlBr form mixed crystals having a CsCl lattice at low temperatures but change into the NaCl -lattice with increase of temperature. The temperature at which this happens increases with the proportion of TlBr but is limited by the point at which sublimation occurs. It is concluded from the lattice changes of these mixed crystals that in alkali halide-thallium phosphors, the volume of the activating Ti^+ is equal to that of the lattice cation displaced by it.

H.H.Hodgson

548.33

6358. LOW-TEMPERATURE PHASE TRANSITION OF CRYSTALLINE HEXAMETHYLBENZENE. II. O.Schnepf. J. chem. Phys., Vol. 30, No. 1, 48-52 (Jan., 1959).

For previous work see Abstr. 198 (1959). The absorption spectrum of the ab plane of crystalline hexamethylbenzene in polarized light was studied. This spectrum is forbidden and isotropic below the λ -point transition at 110°K and allowed and very anisotropic above this temperature. It is proposed that these results support the conclusions presented in an earlier paper based on the spectrum of the bc plane. A crystal field calculation of the intensity expected to be induced by this perturbation is shown to support also the conclusion that the molecule is slightly distorted in the high temperature crystal modification. A mechanism for the phase transition is proposed and is based on the assumption that the methyl groups begin to rotate about the C-C bond at 110°K.

548.5

6359. AN ELECTRON DIFFRACTION STUDY OF ICE DEPOSITS FORMED ON SILVER IODIDE. N.D.Lisgarten. Phil. Mag. (Eighth Ser.), Vol. 3, 1306-11 (Nov., 1958).

Oriented deposits of hexagonal ice were formed by condensing water vapour on to silver iodide substrates at temperatures of about

-100°C and examined by electron diffraction methods. A feature of the diffraction patterns, obtained from the oriented hexagonal ice, is the appearance of strong spots in the "forbidden" h k 4 positions. At lower substrate temperatures only unoriented deposits of cubic ice were obtained.

548.51

6360. STUDIES ON THE CRYSTAL GROWTH OF SOLUBLE METAL SALTS. II. THE FACTORS THAT DETERMINE THE PARTICLE SIZE OF CRYSTALS GROWN BY COOLING HOT SUPER-SATURATED SOLUTIONS. A.Packter.

Z. phys. Chem. (Leipzig), Vol. 210, No. 3-4, 196-208 (March, 1959).

For Pt I, see J. phys. Chem., Vol. 59, No. 11, 1140-3 (Nov., 1955). Experimental and theoretical study. Crystal growth may be considered schematically as a two-stage process: the formation of nuclei or "seeds", followed by a (slow) growth on to these seeds. At low rates of cooling, the particle size of the crystals deposited varies inversely as a low power of the rate of cooling, and of the rate of development of supersaturation; and varies with the critical supersaturation according to a mass-action relation. At rapid rates of cooling, the main crystal growth takes place after the solution has reached the final temperature; and the crystal size depends on the final supersaturation according to the mass action relation, observed with the rapid precipitation of sparingly soluble metals salts from supersaturated solution.

548.52

6361. THE DISCONTINUOUS COVERING OF COPPER BY CUPROUS OXIDE. E.Menzel, W.Stossel and C.Menzel-Kopp. Z. Naturforsch., Vol. 12a, No. 5, 404-9 (1957). In German.

Single, relatively large cuprous oxide crystals are produced in the thermal oxidation at low oxygen pressure of pure undisturbed copper surfaces. Their growth and form (shown in photographs and diagrams) were observed with an optical microscope. The lattice chains of greatest population density control the growth. The discontinuous layers show optical anisotropy which arises from the orientation of rod-like crystallites of Cu_2O .

W.Good

- 548.52
6362. STEP-WISE AND SPIRAL CRYSTAL GROWTH IN HIGH POLYMERS. E.W.Fischer.
Z. Naturforsch., Vol. 12a, No. 9, 753-4 (1957). In German.
A short description of electron-microscope and electron-diffraction observations on polythene and nylon. A.R.Stokes
- 548.52
6363. PRODUCTION OF CRYSTALS FROM UNSTABLE COMPOUNDS. A.Fischer.
Z. Naturforsch., Vol. 13a, No. 2, 105-10 (Feb., 1958). In German.
Many crystals under normal pressures decompose at temperatures well below their melting point. An oven is described, which allows the melting of such unstable crystals; it operates up to temperatures of 2500°C and pressures of 150 atm. Some preliminary results are described of the growth of crystals of GaP, BP, ZnS and CdS. B.T.M.Willis
- 548.522 : 535.376
6364. PREPARATION OF ZINC SULFIDE SINGLE CRYSTALS. T.Matsumura, H.Fujisaki and Y.Tanabe.
Sci. Rep. Res. Insts Tohoku Univ. A, Vol. 10, No. 6, 459-71 (Dec., 1958).
Rod crystals were prepared by the gas reaction (Frerichs) and the sublimation (Kremheller) methods. The former method was capable of growing crystals of nearly $8 \times 0.3 \times 0.1$ mm from pure Zn metal kept at 1100°C for only half an hour in H₂S gas atmosphere. The latter method enabled one to obtain crystals (5-8 mm in length and 0.3-1 mm in sectional diameter) from ZnS powder kept at 1220°C for 8 hours in an inert gas stream. It was found that relatively large crystals grew under steady condition at just above sublimation temperature. Crystals obtained by the sublimation method displayed electroluminescence with both a.c. and d.c. excitation, without any activator. The growth conditions of needle, twin and ribbon crystals are also discussed.
- 548.527
6365. THE EFFECT OF ADSORPTION ON THE GROWTH OF CRYSTALS. G.Blisnakov and E.Kirkova.
Z. phys. Chem. (Leipzig), Vol. 206, No. 3-4, 271-80 (Feb., 1957). In German.
Measurements were made of the rate of growth of the (111) and (100) faces of NaClO₃ and Pb(NO₃)₂. NaClO₃ crystals were grown from solutions containing varying amounts of Na₂SO₄, the Pb(NO₃)₂ crystals were grown in the presence of methylene blue. J.Franks
- 548.538
6366. ORIENTED GROWTH OF TUNGSTEN CARBIDE ON COPPER MONOCRYSTAL SPHERES. C.Menzel-Kopp.
Z. Naturforsch., Vol. 12a, No. 12, 1003-6 (1957). In German.
When Cu monocrystal spheres obtained by asymmetric cooling on W ribbon in a high vacuum (cf. Menzel, Stüssel and Otter, Abstr. 1724/1956) were coated with a C compound and annealed for a short time, there appeared on them a layer of hexagonal W₂C. A complete epitaxy of W₂C with respect to Cu was revealed by electron diffraction in reflection. In both lattices the chains in composition planes, characterized by greatest densities of metal atoms, are nearly parallel to each other. F.Lachman
- 548.538
6367. THERMAL OXIDATION OF SILVER CRYSTALS. E.Menzel and C.Menzel-Kopp.
Z. Naturforsch., Vol. 13a, No. 11, 985-7 (Nov., 1958). In German.
Spherical single crystals were oxidized between 200 and 370°C under oxygen pressures of up to 100 atm. A discontinuous surface layer of Ag₂O was produced; it consisted of crystallites, whose form and crystallographic orientation are given. The epitaxial features described are similar to those shown by the system Cu/Cu₂O. B.T.M.Willis
- 548.55
6368. PURIFICATION OF SUBSTANCES BY GROWTH OF SINGLE CRYSTALS FROM THE MELT, AND THE DISTRIBUTION OF IMPURITIES IN CRYSTALS. G.Schreiber and R.Schubert.
Z. phys. Chem. (Leipzig), Vol. 206, No. 1-2, 102-23 (Nov., 1956). In German.
The residual melt process (growth of a crystal, leaving a residue) is a more efficient purification technique than zone melting. With the residual melt process, a very uniform distribution of impurities is obtained, provided only a small amount of the original material is used. J.Franks
- 548.574
6369. ETCH PITS AND TRIGONS ON DIAMOND. I. F.C.Frank, K.E.Puttick and E.M.Wilks.
Phil. Mag. (Eighth Ser.), Vol. 3, 1262-72 (Nov., 1958).
On the faces of a type I diamond octahedron of particularly good quality there have been observed clusters of trigons which appear to be associated with a centre of strain in the interior of the stone. The trigon patterns show features which can only have been the result of surface dissolution. These observations are discussed, and it is concluded that most trigons are etch pits; there is evidence that these particular trigons are centred on dislocations. Possible explanations are considered for the fact that the usual laboratory etchants develop pits oppositely oriented to trigons.
- 548.574
6370. ETCH PITS AND TRIGONS ON DIAMOND. II. F.C.Frank and K.E.Puttick.
Phil. Mag. (Eighth Ser.), Vol. 3, 1273-9 (Nov., 1958).
Some experiments on artificial etching of diamonds are described. Etching in steam and chlorine at temperatures of around 800°C produces etch pits in "positive" orientation (i.e. opposed to that of natural trigons). Wet hydrogen in the same temperature range and above gives inconclusive results. Etching in this medium may be greatly accelerated by the presence of some catalyst. Diamonds heated in fused kimberlite at about 1450°C develop sharp-edged triangular pits in "negative" trigon orientation. The bearing of this observation on the natural history of diamond is briefly discussed.
- 548.574
6371. GRAIN BOUNDARY ETCHING ON PURE ALUMINIUM. I.Braun, F.C.Frank and G.Meyrick.
Phil. Mag. (Eighth Ser.), Vol. 3, 1312-17 (Nov., 1958).
In the etching of recrystallized aluminium (both of 99.99% purity, and zone-refined material) in Lacombe and Beaujard's etchant, the grain boundaries are found to resist attack immediately after electropolishing, but to become susceptible to severe attack after periods of a few days at room temperature. It is suggested that this behaviour is due to diffusion of impurities along the grain boundaries, into the oxide film.

X-RAY CRYSTALLOGRAPHY

548.73/74
X-RAY AND ELECTRON INVESTIGATION OF MATERIALS.
See also the Section entitled "STRUCTURE OF SOLIDS".

548.732
6372. DOUBLE BRAGG SCATTERING IN COLD-WORKED METALS. M.B.Webb and W.W.Beeman.
Acta metallurgica, Vol. 7, No. 3, 203-9 (March, 1959).

The small angle X-ray scattering from cold-worked metals is examined in terms of a double Bragg scattering mechanism. The intensity and angular distribution of the scattering expected from this mechanism are calculated and found to be in accord with experiment. It is shown that this mechanism should give a strongly polarized scattered flux at small angles and that the strong electric vector should be radial in the detecting plane. The polarization of the scattered flux was measured and found in agreement with these predictions. It is concluded that the double Bragg process and not density fluctuation scattering is responsible for most of the observed small-angle scattering.

548.732 : 535.135
GROUP VELOCITY, ENERGY FLOW DENSITY AND ENERGY DENSITY IN THE X-RAY OPTICS OF CRYSTALS. See Abstr. 5471

548.733
6373. APPLICATION OF THE PARALLEL-RAY METHOD, IN TRANSMISSION, TO THE TESTING OF CRYSTALLINITY WITH X-RAYS. H.Barth and R.Hosemann.
Z. Naturforsch., Vol. 13a, No. 9, 792-4 (Sept., 1958). In German.
X-rays from a line-focus tube are diffracted by the crystal specimen, and a wire gauze if placed either in the incident beam or in the diffracted beam: the sharpness of the shadow of the gauze indicates the degree of perfection of the crystal. A.R.Stokes

- 548.734
6374. X-RAY ANALYSIS OF CRYSTAL STRUCTURE WITH FOLD INTEGRALS. I. METHOD OF CALCULATION AND INFORMATION ANALYSIS. R.Hosemann and G.Schoknecht.
Z. Naturforsch., Vol. 12a, No. 11, 932-9 (1957). In German.
A new method is to be described. This part is an introductory survey of the methods of calculating electron-density distributions and the difficulties that arise from cut-off effect in Fourier summations.
A.R.Stokes

- 548.734
6375. X-RAY ANALYSIS OF CRYSTAL STRUCTURE WITH FOLD INTEGRALS. II. METHOD OF MEASUREMENT, AND DETERMINATION OF ELECTRON DENSITY IN NaCl. G.Schoknecht.
Z. Naturforsch., Vol. 12a, No. 12, 983-96 (1957). In German.
The NaCl structure at room temperature was completely determined by means of the previously described method (Hosemann and Schoknecht, see preceding abstract), the apparatus consisting of a spectrometer, a quartz monochromator and a counter. The distribution of electron density in NaCl is fully described, using ten parameters. A comparison of the experimentally determined distributions for Cl^- and Na^+ with theoretical curves of Hartree, and the recalculation by means of Debye factors indicate that characteristic displacements of charge distributions have taken place in the crystal lattice (anion tightening and cation loosening, as predicted by Kossel and Fajans).
F.Lachman

- 548.734
6376. ON THE INFLUENCE OF ASYMMETRIC DISTRIBUTION FUNCTIONS ON PRECISION LATTICE CONSTANT MEASUREMENTS. M.Wilkens.
Z. angew. Phys., Vol. 10, No. 9, 433-44 (Sept., 1958). In German.
In X-ray diffraction measurements on lattice spacings, the measured intensity distribution at a diffraction maximum will be affected by: (1) the wavelength-intensity distribution in the $K\alpha$ line used — the half value widths and asymmetries of $K\alpha$ Cr—Mo are tabulated and Fe— $K\alpha$ is not a good line; (2) variations of lattice space in the specimen used; (3) instrumental asymmetries, which can be minimized by an extrapolation method. It is not recommended to compare measurements with different wavelengths because of uncertainty in corrections for selective absorption and refraction in the crystal.
G.F.Loithian

- 548.735.4
6377. THE USE OF ATOMIC RADII IN THE DISCUSSION OF INTERATOMIC DISTANCES AND LATTICE CONSTANTS OF CRYSTALS. L.Pauling.
Acta cryst., Vol. 10, Pt 11, 685-7 (Nov., 1957).
The system that has been used by various authors in the past for discussing interatomic distances and lattice constants of crystals in terms of atomic radii is described. It is pointed out that in recent papers Geller [Acta cryst., Vol. 9, 885 (1956); Vol. 10, 380 (1957)] has discussed the lattice constants of compounds with the β -wolfram structure in a way that deviates from past usage.

- 548.735.4
6378. COMMENTS ON THE PRECEDING PAPER BY L.PAULING ENTITLED "THE USE OF ATOMIC RADII, ETC.". S.Geller.
Acta cryst., Vol. 10, Pt 11, 687 (Nov., 1957).
See preceding abstract. The author believes that his position regarding the various aspects of the β -W type structure has been made abundantly clear in his two previous papers, and therefore, that there is no point in his further discussing Pauling's paper.

- 548.735.7 : 539.2
X-RAY RECORDING OF DISTORTION FIELD ROUND ISOLATED DISLOCATIONS IN GERMANIUM SINGLE CRYSTALS.
See Abstr. 6268

- 548.735.7 : 539.2
X-RAY DETERMINATION OF THE TYPE OF ISOLATED DISLOCATIONS IN SINGLE CRYSTALS. See Abstr. 6269

- 548.737
6379. LATTICE STRUCTURES WITH SPATIAL HYDROGEN-BRIDGE SYSTEMS AND LATTICE TRANSFORMATIONS IN POLY-AMIDES. G.F.Schmidt and H.A.Stuart.
Z. Naturforsch., Vol. 13a, No. 3, 222-5 (March, 1958). In German.
A lattice structure degeneration to monoclinic system ($a = b$, and $\gamma = 60^\circ$) is found in most cases in 8-nylon. This is due to the known grid-plane system being replaced by a spatial hydrogen-bridge system. This results in a direct higher orientation becoming impossible. The triclinic (high-temperature) modifications of 7-, 11-, 6,6- and 8,10-nylon are likewise systems with hydrogen bridges. The causes of the formation and stability of these spatial lattices are discussed.
F.Lachman

- 548.74
6380. AN AUTOMATIC TIMING AND RECORDING CIRCUIT FOR USE WITH A NEUTRON CRYSTAL SPECTROMETER. D.O'Connor and K.Blinowski.
Acta phys. Polon., Vol. 16, No. 4, 293-8 (1957).
The angular position, time of measurement and intensity of the primary and scattered neutron beams are registered and recorded on an electric desk adding machine. The circuits ensure the most economic use of the measurement time available by relating the time duration and angular frequency of measurement points to the scattered beam intensity.

- 548.74
6381. NEUTRON DIFFRACTION STUDY OF GYPSUM, $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$. M.Atoji and R.E.Rundle.
J. chem. Phys., Vol. 29, No. 6, 1306-11 (Dec., 1958).
Using neutron diffraction data, the crystal structure was refined by Fourier and least squares methods. The hydrogen bond distance was found to be 2.82 Å rather than 2.71 Å, reported previously. The hydrogen positions are consistent with those obtained from nuclear magnetic resonance. The O—H distance is 0.99 ± 0.03 Å, and it appears that the O, H, O atoms are collinear. Infrared and Raman results are discussed in terms of the refined structure.

GEOPHYSICS

550.312

6382. A DETERMINATION OF THE COEFFICIENT J OF THE SECOND HARMONIC IN THE EARTH'S GRAVITATIONAL POTENTIAL FROM THE ORBIT OF SATELLITE 1958 β_2 .

M.Lecar, J.Sorenson and A.Eckels.

J. geophys. Res., Vol. 64, No. 2, 209-16 (Feb., 1959).

From the secular changes in the longitude of the node and the argument of the perigee, the coefficient J in the gravitational potential function

$$U = \frac{\mu}{r} \left[1 + J \left(\frac{ae}{r} \right)^2 \left(\frac{1}{3} - \sin^2 \phi \right) + \frac{K}{30} \left(\frac{ae}{r} \right)^4 (3 - 30 \sin^2 \phi + 35 \sin^4 \phi) \right]$$

was determined to be $(1.6232 \pm 0.0005) \times 10^{-3}$. If the bounding equigeopotential surface of the earth is assumed to be an ellipsoid of revolution, this value of J implies a flattening f of $1/298.32 \pm 0.05$.

550.38

6383. THE GEOMAGNETIC FIELD LINES IN HIGHER APPROXIMATION. B.Hultqvist.

Ark. Geofys., Vol. 3, Paper 4, 63-77 (1958).

The deviation at the earth's surface of the geomagnetic field lines, in an approximation including the five first spherical harmonic terms, from the dipole lines is calculated by a perturbation method, on the basis of Vestine's et al. analysis of the geomagnetic field for epoch 1945, and the result is discussed with regard to some problems in geomagnetism, aurora, cosmic rays and whistlers.

550.385 : 551.57

6384. RELATION OF GEOMAGNETIC DISTURBANCES TO CIRCULATION CHANGES AT 30000 FOOT LEVEL.

N.J.Macdonald and D.D.Woodbridge.

Science, Vol. 129, 638-9 (March 6, 1959).

From analyses of waves in the circulation pattern at the jet-stream level of the atmosphere during the winters of 1956-57 and 1957-58, it was found that, in comparison with other waves, those which appeared in the Alaska-Aleutian area about 3 days after a magnetic disturbance subsequently developed into large-amplitude disturbances.

550.385 : 537.591.5

MAGNETIC AND COSMIC RAY STORMS. See Abstr. 5864

550.4

6385. ON THE DETERMINATION OF THE RADON CONTENT IN TELLURIC AIR BY MEANS OF NUCLEAR PLATES.

G.Aliverti, A. de Maio, G.Lovera, R.P.Fedeli and L.Sacchetti.

Nuovo Cimento, Vol. 10, No. 1, 68-77 (Oct. 1, 1958). In Italian.

This technique consists in exposing emulsion in an enclosure to air containing radon in equilibrium with its decay products. The effect of radioactive atoms deposited on the surface is eliminated by a subtraction technique based on a study of the α -particle range distribution in the emulsion. The radioactivity per unit volume of air may then be determined absolutely, making use of a simple theoretical expression.

R.H.W.Johnston

550.93

6386. ON THE AGE ESTIMATION OF MINERALS BY THE RUBIDIUM-STRONTIUM METHOD.

H.Ewald, G.Felkel, E.Hebeda and H.Kocher.

Z. Naturforsch., Vol. 13a, No. 3, 235 (March, 1958). In German.

The use of an optical method to determine the Rb/Sr ratio is described and it is shown that this yields the same order of accuracy as the use of mass-spectroscopic methods.

J.M.Hough

550.93

6387. ISOTOPE COMPOSITION OF SEVERAL GALENAS.

H.F.Ehrenberg and H.J.Mürtz.

Z. Naturforsch., Vol. 13a, No. 10, 854-5 (Oct., 1958). In German.

The relative quantities of the lead isotopes in various galena samples were measured, using the mass-spectroscopic method at Bonn. Some of these results were found to duplicate those obtained by the Bern mass-spectroscopic. Using these measurements, the ages of the investigated rock samples were estimated.

D.H.Lord

ATMOSPHERE . IONOSPHERE

551.510.535

6388. A STUDY OF NOON F_2 IONIZATION IN RELATION TO GEOMAGNETIC CO-ORDINATES. J.N.Bhar and P.Dhar Bhowmik.

Indian J. Phys., Vol. 33, No. 1, 1-17 (Jan., 1959).

The relation of the F_2 -layer noon critical frequency to magnetic dip and geomagnetic latitude is studied for constant values of solar zenithal angle. The constant- χ plots show two maxima situated on the two sides of the magnetic equator. An asymmetry between the northern and southern hemispheres is also revealed. For chosen values of solar zenith distance, the ratio of noon fF_2 at sunspot maximum to that at sunspot minimum is studied in relation to magnetic dip. The ratio is found to vary with magnetic dip displaying a minimum to the north of the magnetic equator.

551.510.535

6389. ARCTIC MEASUREMENTS OF ELECTRON COLLISION FREQUENCIES IN THE D-REGION OF THE IONOSPHERE.

J.A.Kane.

J. geophys. Res., Vol. 64, No. 2, 133-9 (Feb., 1959).

Electron collision frequencies in the D-region were measured with the aid of rockets launched during polar blackouts at Fort Churchill, Canada (58° N). During the blackouts the ionization content of the D-region was large enough to cause a strong altitude-dependent absorption of a 7.75 Mc/s c.w. signal, radiated from the rocket. The refractive indices and the difference absorption of the two magneto-ionic components of this signal were simultaneously measured versus altitude. The electron collision frequency profile was then determined from these measurements. The results from two midday rocket flights, one made in July 1957 and the other in November 1956, indicate that the electron collision frequencies in the Arctic D-region are lower by a factor of three than in the standard values calculated by Nicolet (1957). At 70 km the measured value of the collision frequency is $(1.0 \pm 0.3) \times 10^7 \text{ sec}^{-1}$.

551.510.535

6390. POLAR IONOSPHERIC DISTURBANCES ASSOCIATED WITH A SEVERE MAGNETIC STORM. T.Obayashi.

J. Geomagn. Geoelect., Vol. 10, No. 1, 28-35 (1958).

A detailed investigation is made of a severe magnetic storm on 28 October, 1951, using world-wide simultaneous geomagnetic and ionospheric data. It has been found that an outstanding electrojet stream, comparatively short-lived, appeared near the southern edge of the auroral zone at the end of the main phase of this storm. The ionospheric disturbance associated with this electrojet was anomalous; the electron density of the F_2 -layer above the electrojet stream increased suddenly to more than 10^6 electrons/cm³ and then dropped below normal after the disappearance of the current stream. Although no existing theory of ionospheric storms can explain satisfactorily this anomalous change, two possible mechanisms are suggested from consideration of the direct association of geomagnetic and ionospheric variations. One is the effect of the incoming corpuscular precipitation into the ionosphere and the consequent formation of a new F_2 -layer due to the increase of ionization. The other is due to the vertical drift of electrons produced by the interaction of the geomagnetic field with the currents in the F_2 -region returning from the main electrojet formed in the E-region.

551.510.535 : 537.531 : 523.775

EFFECTS ON THE IONOSPHERE OF X-RAYS FROM CORONAL CONDENSATIONS. See Abstr. 5326

551.510.535

RADIO-WAVE PROPAGATION IN THE IONOSPHERE. See also the Section entitled "ELECTROMAGNETIC WAVES AND OSCILLATIONS".

551.513 : 525.3

ROTATION OF THE ATMOSPHERE. EARTH SATELLITE DATA. See Abstr. 5338

551.515.4
6391. THE ELECTRICAL STRUCTURE OF THUNDERSTORMS. Y. Tamura, T. Ogawa and A. O. Okawati. J. Geomagn. Geoelect., Vol. 10, No. 1, 20-7 (1958).

The simultaneous observation of thunderstorm electricity was made at eight stations during the summer of 1957. The potential-gradient changes from a number of lightning flashes were analysed. Within the cloud, the electric moments were destroyed at the height from 4 to 7 km and the values of the moments were distributed to the extent of 70 C km. By means of cloud-ground flashes, negative charges to the extent of about 30 C, were transferred to the earth through a distance of from 4 to 11 km. The cloud flashes and the earth flashes occurred at different horizontal positions in the cloud, as well as at different levels. Referring to the aerological data, the location of the charge centre or the charge-separation level was related with the air temperature. The average results give a picture of a thundercloud similar to that of double dipole by Kuettnner.

551.521.11
6392. SOLAR SPECTRAL IRRADIANCE AND VERTICAL ATMOSPHERIC ATTENUATION IN THE VISIBLE AND ULTRAVIOLET. L. Dunkelman and R. Scolnik. J. Opt. Soc. Amer., Vol. 49, No. 4, 356-67 (April, 1959).

The solar spectral irradiance outside the earth's atmosphere was determined by Langley's method of extrapolation to zero air mass, from measurements taken on Mount Lemmon at an elevation of 8025 ft near Tucson, Arizona, during October, 1951. The spectrum was produced and the energy scanned by a Leiss quartz double-monochromator, detected by a 1P21 photomultiplier, amplified, and presented on a strip chart recorder. About twenty-five spectra were recorded from sunrise to noon, with bandwidths ranging from 10 at 3030 Å to 170 at 7000 Å. The equipment was calibrated frequently by recording the spectrum of a standard tungsten lamp. Compared with earlier work performed in this field, our results agree best with those of Pettit. There is good agreement with the direct measurements from a rocket obtained by Purcell and Tousey in 1954 and with the Sacramento Peak ultraviolet observations by Stair and Johnston in 1955. The change of solar intensity with air mass showed that the attenuation of the atmosphere above Mount Lemmon was approximately 15% higher than that for a Rayleigh atmosphere in the region 3400 to 4650 Å, where there is no absorption due to ozone. A discussion in included which emphasizes the importance of clear and constant atmospheres which are necessary to obtain accurate values of solar spectral irradiance outside the earth's atmosphere by the Langley method. The solar illuminance computed from spectral data was 12 700 lumens/ft².

551.521.13 : 535.434
ELLIPTICITY OF POLARIZATION OF SCATTERED LIGHT. See Abstr. 5594

551.521.326 : 539.19
LABORATORY STUDY OF THE OH-RADICAL ROTATIONAL-VIBRATIONAL BONDS OBSERVED IN THE INFRARED NIGHT-SKY GLOW. See Abstr. 6186-7

551.524
6393. NOTE ON RADIATIVE DIVERGENCE AS DETERMINED BY THE "BLACK BALL". V. E. Suomi, J. A. Businger and P. M. Kuhn. REPLY. J. L. Gergen.

J. Meteorol., Vol. 15, No. 4, 411-12, 412-16 (Aug., 1958). Describes an experiment to test Gergen's claim that the heating or cooling of the atmosphere may be estimated from the difference in temperature ($T_r - T_a$) of the black ball and the ambient air. The instrument, used on balloon flights, measured the net radiation and not the total radiation as in Gergen's measurements. The results show that there is no simple relation between the rate of heating or cooling of the atmosphere and ($T_r - T_a$). Gergen presents results from a flight similar to that of Suomi et al, and indicates the experimental difficulties. It is emphasized that the experimental results are subject to large systematic errors and that there is a background of experimental evidence, though not conclusive, for the author's claim. S. Weintraub

551.575 : 536.423
THE RELATIVE IMPORTANCE OF CONDENSATION AND COALESCENCE PROCESSES ON THE STABILITY OF A WATER FOG.. See Abstr. 5624

551.593.55
6394. SODIUM IN THE EARTH'S UPPER ATMOSPHERE. T. M. Donahue. J. appl. Phys., Vol. 30, No. 1, 34 (Jan., 1959).

A discussion of recent theoretical and experimental studies of the sodium airglow. The effects of self-absorption, and scatter by the atmospheric Na on night- and twilight-emission are considered. A solution of the radiation transport problem, involving a spherical Na layer at 85 km altitude, predicts that the intensity of the Na twilight glow will attain a minimum at 2° solar depression, and a maximum between 6° and 7°. Recent observations (1958) of the abundance of atmospheric Na made in S. France, and Canada, yield values of between 2×10^9 and 30×10^9 atoms/cm², and between 1×10^9 and 10×10^9 atoms/cm² respectively. The observations in S. France show also a markedly different seasonal distribution compared with the Canadian results, with a double maximum (Nov., Mar.) instead of a single (Mar.) maximum in Canada. A significant W-E asymmetry in the geographical distribution of the Na appears in the French observations, about twice the amount lying in the direction of the Atlantic Ocean than over the land. It is concluded that the terrestrial oceans may have a direct influence on the distribution and abundance of upper atmosphere Na; but more experimental data are required to check this. D. R. Barber

551.594.1
6395. THE LOCAL ANOMALY OF THE DIURNAL VARIATION OF THE ATMOSPHERIC ELECTRIC FIELD. M. Kawano. Researches Electrotech. Lab. (Tokyo), No. 569, 51 pp. (July, 1958).

A comprehensive experimental and theoretical study of the diurnal variations, in summer and winter, of the electrical field, electrical conductivity and space charge density of the atmosphere, on meteorologically quiet days at two stations A and B, 25 km apart in Tokyo. On account of atmospheric turbidity due to industrial activity, the variations at A, which is situated in the city, are markedly different from those observed at B, which are characteristic of rural areas. The differences are explained by considering the ionization equilibrium, taking into account eddy diffusivity (coefficient calculated from the observations to be about 50×10^8 cm²/sec by day and 5×10^8 cm²/sec at night), and the measured rate of ion pair production by radioactive substances in the atmosphere (3-10 J, maximum by day), by penetrating radiation from the ground (3 ± 0.1 J) and by cosmic rays (2.35 J; J denotes the number of ion pairs produced per cm³ per sec. The vertical distribution of the air resistivity in the exchange layer is also discussed. J. Dutton

551.594.12
6396. SOME OBSERVATIONS OF LOW-LEVEL ION CLOUDS. C. J. Brasefield. J. geophys. Res., Vol. 64, No. 2, 141-8 (Feb., 1959).

Simultaneous measurements have been made of the atmospheric potential at 33, 21 and 8 m above ground level, using three radioactive probes. The current from each probe to ground passed through a number of 100 000 megohm resistors and the i-r drop across a terminal resistor of 400 megohms was measured. These measurements indicate that clouds of ions whose net charge was sometimes positive and sometimes negative frequently passed overhead at altitudes of 10 m and less. The origin of the ion clouds is uncertain, but it appears that some, if not all, were produced by motor vehicles, particularly diesel-powered vehicles.

551.594.12 : 523.75
6397. IONIZATION OF THE UPPER ATMOSPHERE BY LOW-ENERGY CHARGED PARTICLES FROM A SOLAR FLARE. H. Leinbach and G. C. Reid. Phys. Rev. Letters, Vol. 2, No. 2, 61-3 (Jan. 15, 1959).

Recordings of 27.6 Mc/s cosmic noise at three northern high latitude stations on July 29, 1958 showed, after the recovery from the usual sudden cosmic noise absorption (SCNA) coincident with a visible class 3 solar flare, a second increase in absorption which persisted for at least 22 hours. This post-flare absorption may be attributed to ionization at the 60-70 km level by charged particles emitted from the sun at the time of the flare. Protons having energies 1-30 MeV would penetrate to the required depth at stations having a magnetic latitude > 68°. G. M. Brown

551.594.14
6398. FLUCTUATIONS OF THE CONCENTRATION AND THE PROPORTION OF RADON AND THORON DESCENDENTS IN THE AIR FROM MEASUREMENTS IN THE NORTH ALPS. R.Reiter. Z. Naturforsch., Vol. 12a, No. 9, 720-31 (1957). In German.

Measurements were made by the filter method and a strong dependence on the wind direction was found. Snow on the mountains had a very large effect on the Thoron descendents radioactivity. Wind velocity and humidity had little effect on the radioactivity.

J.M.Hough

551.594.5
6399. PHOTOMETRIC OBSERVATIONS OF THE 5577 A AND 6300 A EMISSIONS MADE DURING THE AURORA OF FEBRUARY 10-11, 1958. E.R.Manring and H.B.Pettit. J. geophys. Res., Vol. 64, No. 2, 149-53 (Feb., 1959).

Intense auroral activity was recorded on airglow photometers at Sacramento Peak, New Mexico, and an Tonantzintla, Mexico. At Sacramento Peak the whole sky varied in intensity from 10^5 to 10^8 Rayleighs for the 6300 A emission, and from slightly less than 10^5 to more than 10^4 Rayleighs for the 5577 A emission. The ratio of the intensity of the 6300 A emission to that at 5577 A was about 2.5×10^3 throughout the night. There was no enhancement of the 5890 A emission. At Tonantzintla, the 5577 A emission varied from 200 to 600 Rayleighs. Contour lines of equal intensity were nearly perpendicular to the geomagnetic meridian at both sides. An interesting correlation occurs between absorption measurements of cosmic radio noise made at Boulder, Colorado, and the intensity variation of the 5577 A and 6300 A emissions as observed at both Sacramento Peak and Tonantzintla.

551.594.5

6400. AURORAL IONIZATION AND MAGNETIC DISTURBANCES. B.Nichols.

Proc. Inst. Radio Engrs, Vol. 47, No. 2, 245-54 (Feb., 1959).

An examination of radio studies of auroral ionization shows that an average ionization density of about 5×10^5 electrons per cm^3 is sufficient to explain the normal radar echo. The magnetic disturbances produced by current systems in the ionosphere are closely related both to the ionization and the luminosity of the aurora. The magnetic variations are also associated with increases in the speeds of motion of the ionization. The increased ionization manifest in the aurora, together with its increased speed of motion, brings about the magnetic changes observed at the ground. The rapid speeds of auroral motions observed both visually and by radio means are at the upper end of a continuous curve of drift motions that increase with increasing magnetic disturbance.

551.594.5 : 621.396.969

6401. A LOW POWER V.H.F. RADAR FOR AURORAL RESEARCH. R.S.Leonard.

Proc. Inst. Radio Engrs, Vol. 47, No. 2, 320-2 (Feb., 1959).

A 5 kW, 41 Mc/s radar which was designed for use in the U.S.

I.G.Y. programme is described. The standard operating procedures are outlined and a sample of the records is shown. The design of a scaling machine is discussed and a method of utilizing the scaled data to produce an auroral echo activity index is described.

551.594.51

6402. AURORAL PHENOMENA. E.N.Parker.

Proc. Inst. Radio Engrs, Vol. 47, No. 2, 239-44 (Feb., 1959).

The auroral patterns are strongly influenced by the geomagnetic field, forming curtains and rays along the magnetic lines of force. The details of the optical excitation in the aurora are very complicated and not well understood. It is clear that both electrons and protons are necessary and that these exciting particles must be accelerated in the vicinity of Earth. There are only rough and untested ideas as to how the protons are accelerated, and why the auroras show a preference for latitude $\pm 65^\circ$.

551.594.52

6403. ON THE SHAPE OF THE AURORAL ZONES. L.Block.

Ark. Fys., Vol. 14, Paper 13, 153-60 (1958).

Model experiments on Alfvén's theory of aurorae, performed earlier by the author (Abstr. 7549/1955), resulted in auroral zones with a smaller eccentricity than theoretically expected if space charges are neglected. Preliminary measurements of the charges in the model have now been made, and on the basis of this it is to account theoretically for the smaller eccentricity. From the theory, it also emerges that the measured space charge distribution will tend to increase the polar distance of the auroral zones. The influence of variable terrella voltage was also investigated and the result shows good agreement between theory and experiment.

551.594.6 : 621.396.821

6404. A 27 kc/s SUDDEN ENHANCEMENT OF ATMOSPHERICS ANOMALY. W.A.Feibelman.

J. geophys. Res., Vol. 63, No. 4, 866 (Dec., 1958).

Shows a recorded trace for May 1, 1958 indicating a sharp drop in signal level followed by a gradual rise, in two instances, following solar flares. Normally signal enhancement is observed.

G.D.Sims

551.596 : 534.23

6405. INFLUENCE OF TURBULENCE ON THE ATTENUATION OF SOUND IN FREE AIR. M.Jorand.

C.R. Acad. Sci. (Paris), Vol. 248, No. 9, 1306-8 (March 2, 1959). In French.

Classical theories fail to explain the observed sound attenuation. Better agreement is given by replacing the classical viscosity by an appropriate kinematic viscosity.

H.D.Parbrook

BIOPHYSICS PHYSIOLOGICAL PHYSICS

612.014.482.4 : 539.166.08
LOW-LEVEL GAMMA RAY DETECTION IN HUMANS.
See Abstr. 6101

612.84

6406. QUANTUM LIMITATIONS IN VISION AND TELEVISION. A.Rose.

Acta electronica, Vol. 2, No. 1-2, 33-6 (1957-58).

"Physical problems of colour television" Conference paper (see Abstr. 1006/1958). The ultimate performance of any picture pick-up system is limited by the number of photons entering the system. This limitation holds equally for the human eye as it does for a television camera tube. An analysis of the performance of the eye shows that it is making use of a tenth of the photons incident on it. Since modern television camera tubes also make use of a tenth the incident photons, their performance can be assessed by simple reference to one's own visual performance. When the picture presented on a television receiver exceeds the brightness of the original scene, the

sensitivity of the camera tube should exceed that of the eye by the same ratio of brightness in order to transmit a noise-free picture with the same depth of focus as an observer at the scene. Since the sensitivity of the eye is already close to the absolute limit, this condition cannot always be satisfied. To compute the number of photons required to transmit a given amount of information, one must know the visual value of the threshold signal-to-noise ratio. An empirical value for this parameter lies between 4 and 5 rather than close to unity as one might have expected. As a result, about 20 times as many photons are required as would have been computed from a threshold signal-to-noise ratio of unity.

612.843

6407. VISIBILITY OF RECURRENT STRUCTURES IN TELEVISION SYSTEMS WITH INTERLACED SCANNING.

G.A.Boutry and P.Billard.

Acta electronica, Vol. 2, No. 1-2, 61-70 (1957-58). In French.

"Physical problems of colour television" Conference paper (see Abstr. 1006/1958). When line or dot interlaced scanning is used for television display the observer perceives, under certain conditions, the appearance of patterns with uniform translation motion. The condition for the appearance of such patterns are described in this paper. The authors study more particularly line and dot interlaced scanning at the rate of four frames per image. The various systems of interlaced scanning are classified and a description is given of special instrumentation, designed for the experimental study of pattern translation effects. It is shown that perception of these moving patterns is ruled by a law similar to Ferry-Porter's law on image-flicker. Pattern motion occurs only beyond a certain brightness level, the logarithm value of which is proportional to frequency. Brightness varies inversely with structure pitch. Perception of the translation becomes more clear when the pitch of the moving pattern decreases. For a given number of lines, this effect causes less trouble with dot interlaced systems than with line interlaced systems.

612.843.3

6408. PHYSIOLOGICAL OPTICS AND COLOUR TELEVISION:

A SURVEY. W.D.Wright.

Acta electronica, Vol. 2, No. 1-2, 26-32 (1957-58).

"Physical problems of colour television" Conference paper (see Abstr. 1006/1958). Colour reproduction by television can be regarded as a point-by-point process of trichromatic colour matching at very high speed, and, as such, the laws and data of colorimetry enter directly into any first analysis of a colour television system. The present status of these laws and data for medium, large and very small field sizes is therefore reviewed. However, the appearance of a reproduction is determined not merely by the particular red-green-blue mixture focused on the retina, but also by the viewing situation under which the picture is seen, and especially its size, luminance and surround illumination. The problems posed by subjective colour reproduction are accordingly summarized, and consideration is given to possible ways of describing them in numerical terms. In addition, a system has to be judged by its ability to reproduce detail, surface texture, gradations of light and colour, and the like, and the contribution of these items to the total perceptual pattern is discussed. Other features of a reproduction, such as flicker, graininess, scintillations, moiré patterns, colour fringing, and instability of colour and shape, may perhaps most aptly be described as visual irritants. Some viewers are more sensitive to these irritants than others, so that tolerance limits are not easy to specify.

612.843.3

6409. IDENTIFICATION OF SIGNAL LIGHTS. II. ELIMINATION

OF THE PURPLE CATEGORY. R.M.Halsey.

J. Opt. Soc. Amer., Vol. 49, No. 2, 167-9 (Feb., 1959).

For Pt I, see Abstr. 1974 (1959). On hundred observers identified fifty test colours in the violet-green-white region of the chromaticity diagram. They were not allowed to use the name "Purple", but only "Red", "Yellow", "Green", "Blue", and "White". Small areas and low illuminances were used to simulate conditions under which signal lights must be recognized. The results are expressed as chromaticity zones within which the test colours were assigned given colour names with various degrees of certainty. In comparison with earlier data obtained under identical conditions but with a "Purple" category, these results show improved identification of blue signals. Other changes and sources of variability are discussed. The data can be applied to the specification of boundaries for coloured signals.

612.843.31

6410. SOME COLOR DEMONSTRATIONS I HAVE SHOWN.

D.B.Judd.

J. Opt. Soc. Amer., Vol. 49, No. 4, 322-8 (April, 1959).

The Ives Medal Address consisted mostly of demonstrations of phenomena of colour perception. The following demonstrations were attempted: blue arcs of the retina, Maxwell's spot shown with Miles filter (macular pigment as an entoptic phenomenon), attributes of colour perception (Desert Island experiment with Priest charts), colour perceptions of protanopes and deutanopes, metamerism (Stearns, textiles, Granville grays), chromatic adaptation (simultaneous and successive contrast), and colour rendition of light sources (object-colour perception as the projection of the after-image of the background on to the object).

612.843.31 : 621.397.621

6411. SUBJECTIVE VISUAL EFFECTS OF A.N.T.S.C. COLOUR TELEVISION RECEIVER TOLERANCES.

P.S.Carnt and G.B.Townsend.

Acta electronica, Vol. 2, No. 1-2, 77-86 (1957-58).

"Physical problems of colour television" Conference paper (see Abstr. 1006/1958). The variations in receiver performance which viewers will accept in colour television have been investigated for the more important parameters which colour adds to the domestic receiver, i.e. effects due to reference oscillator phase, chrominance, signal gain, and the background controls of the three-gun colour tube. These tolerances are expressed in engineering and colorimetric terms and the correspondence with viewers' reaction is given on a subjective scale. The experiments were devised to simulate domestic viewing, and the variations which typical audiences will accept are compared with those which the trained observer can distinguish under critical conditions. The influence of receiver performance on the choice of normalizing illuminant is discussed.

612.843.31 : 621.397.3

6412. AN INVESTIGATION INTO THE SUBJECTIVE EFFECTS OF SOME DIFFERENCES BETWEEN THE RED, GREEN AND BLUE TRANSFER CHARACTERISTICS OF A COLOUR TELEVISION SYSTEM. T.Jacobs and R.N.Jackson.

Acta electronica, Vol. 2, No. 1-2, 95-102 (1957-58).

"Physical problems of colour television" Conference paper (see Abstr. 1006/1958). In systems employing three primaries, one condition for correct reproduction of coloured and monochrome (grey) pictures is that the overall transfer characteristics of the three primary signals shall be identical. The present experiment has been designed to discover to what extent these transfer characteristics may differ from each other whilst maintaining satisfactory picture reproduction. Pictures from a film scanner are reproduced by a laboratory colour television monitor, the apparatus being adjusted to give the best possible reproduction. Known errors of transfer are then introduced into one primary channel in a random manner and observers are asked to assess the effect of these errors on the pictures according to a numbered scale of predetermined comments. So far the experiment has been conducted using monochrome pictures since the most visible errors have been found to occur in the grey scale. The technique will be extended to include colour pictures. The statistical results obtained are expected to be of value in deciding design and production tolerances for colour television equipment.

612.843.31 : 621.397.3

6413. THE CHOICE OF CHROMINANCE SIGNALS IN THE N.T.S.C. SYSTEM WITH A VIEW TO THE DIFFERENTIAL SENSITIVITY OF THE HUMAN EYE TO COLOUR. F.W.de Vrijer.

Acta electronica, Vol. 2, No. 1-2, 103-9 (1957-58).

"Physical problems of colour television" Conference paper (see Abstr. 1006/1958). In a N.T.S.C.-type colour television system the phase of the subcarrier determines, to a first approximation, the hue, and the amplitude of the subcarrier relative to the value of the luminance signal determines the saturation of the reproduced colour in a colour-receiver. Colour deviations will occur in case of noise in the chrominance channel and in case of phase errors of the receiver subcarrier reference oscillator. These phase errors may be caused by noise or otherwise. The sensitivity of the signal to these effects is influenced by the particular choice of chrominance signals transmitted. In order to make an optimum choice, the differential sensitivity of the human eye to colour has to be taken into account. In this paper known data on hue tolerances are used to calculate the sensitivity to phase-errors in the N.T.S.C.-system. Experiments were performed with an actual colour television system to get more exact numerical data. These data are used to calculate the optimum choice of chrominance signals with respect to subcarrier phase errors. This optimum choice turns out to be not very much different from the actual N.T.S.C.-system. Concludes by making some remarks on the sensitivity to noise in the chrominance channel of the N.T.S.C. signal.

612.843.31 : 621.391 : 621.397.3

6414. THE DEFINITION OF PICTURE QUALITY IN BLACK-AND-WHITE AND COLOUR TELEVISION. P.Neidhardt.

Acta electronica, Vol. 2, No. 1-2, 218-26 (1957-58).

"Physical problems of colour television" Conference paper (see

Abstr. 1006/1958). The question of information content of a television image is a problem of perceptibility of details, a statistical statement which suggests the use of information theory for defining picture quality. The fundamental idea is to obtain a formula representing detail perceptibility by means of its connection with the probability data of the picture elements. Information entropy is derived for detail perceptibility as an entropy of high order. On the basis of this assumption all theorems of information theory are applicable to the calculation of reproduction quality in monochrome and colour television.

612.843.6

6415. THE EFFECT OF CONTRAST IN VISION OF A FIELD WITH FIXED OR MOVING BLURRED EDGE. A. Fiorentini. *Acta electronica*, Vol. 2, No. 1-2, 71-6 (1957-58). In French.
"Physical problems of colour television" Conference paper (see Abstr. 1006/1958). The presence of blurry edges between two areas of different luminance produces a particular phenomenon of visual contrast — i.e., two lines are perceived — a bright line and a dark line separating the blurry edge of each area respectively. This phenomenon improves contour perception. It is of importance for television where the transmission of high luminance gradients requires a large frequency band. Luminance measurements have been carried out at various points of a field comprising two areas of different luminance, separated by a linear luminance gradient. Area luminance levels are within normal television luminance values. Measurements have been carried out by binocular balance. Vision of blurry edges has also been investigated in the case of moving objects. Areas of a similar nature, but with a vibratory motion in a direction perpendicular to the edges, have been displayed to the observer. It has been found that, as long as movement amplitude and rate remain below certain limit values, area motion actually improves the perception of contrast.

612.843.613 : 77

6416. LIMINAL IMAGE SIZE FOR CONVENTIONAL FILM READERS. H.I. Register and A.G. Smith. *J. Opt. Soc. Amer.*, Vol. 49, No. 2, 169-71 (Feb., 1959).

A total of 5000 photographic exposures of small targets of various contrasts were made for the purpose of determining the smallest images which can reliably be detected in a standard film reader. In the majority of cases the liminal image size lay between 10^{-4} and 10^{-3} in. The study indicates that uncorrected predictions made on the basis of ordinary visual contrast discrimination data may be in error by an order of magnitude.

612.843.613

6417. UNIOCLAR AND BINOCULAR SCOTOPIC RESPONSIVENESS OF THE PERIPHERAL RETINA. E. Wolf and M.J. Zigler. *J. Opt. Soc. Amer.*, Vol. 49, No. 4, 394-8 (April, 1959).

Thresholds were determined with a square test field subtending a visual angle of 0.3° and an exposure time of 0.04 sec, for the right eye, the left eye, and both eyes. The test field was presented at 21 retinal points between 30° to the left and 30° to the right of fixation on the horizontal meridian and on a parallel line 1.5° below the meridian. In the binocular curves the thresholds are high at the centre, drop to low levels between 5° and 20° and the gradually rise farther in the periphery. The monocular curves are asymmetrical due to the blind spot in the left field for the left eye, and in the right field for the right eye. Thresholds measured in the blind spot areas are attributed to excitation of marginal elements by scatter of light in the ocular media. Corresponding to the lack of sensitivity occasioned by the blind spot in one eye is a region of enhanced sensitivity in the other eye as if in compensation. The binocular thresholds are lower than the monocular thresholds, indicating slight binocular summation.

612.843.621

6418. EFFECT OF THE SIZE OF A COMPLEX DISPLAY UPON VISUAL SEARCH. J.M. Enoch. *J. Opt. Soc. Amer.*, Vol. 49, No. 3, 280-6 (March, 1959).

This investigation is one of a series of studies designed to determine natural search tendencies during visual search tasks. In this study twelve subjects were presented an ordered series of experimental aerial maps of different size. Their eye traces were recorded on a modified ophthalmograph while they searched for a specific critical detail. As was noted in other experiments of this series, coverage of the display was not uniform. In particular, greatest attention was paid to the centre of the display. Search

behaviour in displays subtending 9° and larger at the eye remained essentially the same. For smaller displays, marked differences were noted. As the size of the display decreased, durations of fixation increased, interfixation distances decreased, concentration of attention in the central area increased, and efficiency decreased. Efficiency is defined as percent of eye fixations falling within the display area. The implications of these findings are discussed.

612.843.72

6419. VISION IN THE HUMAN EYE APPLIED TO THE PROBLEM OF THE EVALUATION OF THE QUALITY OF PROJECTION AND TELEVISION PICTURES. W. Kroebel, F. Arp and H. Baurmeister. *Z. angew. Phys.*, Vol. 10, No. 7, 309-17 (July, 1958). In German.

An apparatus is described in which small moving test objects are presented to an observer's eye. From the results obtained from four observers, an empirical relation is found which relates the size and contrast of the test objects to the degree of success experienced by the observer in recognizing them; within limits the latter increases with an increase of size and of contrast. The relevance of this to picture quality is discussed. E.A. Mussett

612.843.72 : 519.2

6420. STATISTICAL TREATMENT OF MEASUREMENTS ON THE PERCEPTUAL PROPERTIES OF THE HUMAN EYE. F. Arp. *Z. angew. Phys.*, Vol. 10, No. 7, 317-20 (July, 1958). In German.
The formula

$$e = E \left[1 - \frac{\frac{\Delta B}{B} - A}{C - A + \frac{D}{d^2}} \right]$$

occurring in the preceding paper can be rewritten

$$EC + \frac{DE}{y^2} - Cz + Az - \frac{Dz}{y^2} - Ex \equiv 0.$$

Using a least squares approach a method of estimating A, C, D and E, given sets of observed values (x, y, z), is described.

N.L. Johnson

612.85

6421. SYNCHRONISM OF NEURAL DISCHARGES AND THEIR DEMULTIPLICATION IN PITCH PERCEPTION ON THE SKIN AND IN HEARING. G. von Békésy. *J. Acoust. Soc. Amer.*, Vol. 31, No. 3, 338-49 (March, 1959).

The role of the volleys in the sensation of "pitch" on the skin was investigated. It was shown that the existence of rotating skin sensations does not insure perfect synchrony between sinusoidal vibrations and the discharges in the neural pathway. Experiments seem rather to indicate that, just as vibration loudness is a complex result of summation and inhibition, so is pitch sensation on the skin also influenced by summation and inhibition of a large group of end organs. One experiment showed that the pulse rate experienced on the skin is much lower than the pulse rate of the stimulus. This suggests a sort of "demultiplication" in the rate of the neural discharges along the neural pathway. This is one possible way in which synchronism may be maintained between the stimulus and the neural discharges, even though the frequencies transmitted are lowered.

612.858

6422. ACTION OF THE MIDDLE EAR MUSCLES IN NORMAL CATS. R. Galambos and A. Rupert. *J. Acoust. Soc. Amer.*, Vol. 31, No. 3, 349-55 (March, 1959).

Wires were permanently implanted on the round window of the cochlea in cats. The voltage output of ears responding to sound stimulation was thus made continuously available in unanesthetized animals for periods up to 4 months. By cutting the middle ear muscles of one ear and comparing its responses with those derived from the normal ear on the opposite side, it was shown that the muscles: (1) do not appreciably influence absolute sensitivity; (2) contract to intense stimuli within 15 msec of their delivery to either ear; (3) attenuate transmission of tones between at least 500 and 3000 c/s; and (4) significantly protect the ear against damage from intense sounds. Spontaneous contractions sporadically and intermittently introduce a transmission attenuation of several dB in the resting normal cat. The stapedius muscle is much more important than the tensor tympani in producing these effects.

6423. RESPONSES OF THE AUDITORY CORTEX TO REPETITIVE ACOUSTIC STIMULI.

M.H.Goldstein, Jr, N.Y.-S.Kiang and R.M.Brown.

J. Acoust. Soc. Amer., Vol. 31, No. 3, 356-64 (March, 1959).

Electrical responses to low-intensity repetitive clicks and bursts of noise were recorded from the cat auditory cortex. Re-

612.858.4

sponses decrease in size as the repetition rate is increased, and for rates higher than 50/sec are smaller than the "ongoing" activity of the cortex and become difficult to detect visually. An electronic average response computer was used to detect responses to high rates of stimulation. Stimulus-locked responses to clicks and bursts of noise were found for rates up to 200/sec in unanesthetized cats, but only up to 100/sec after anesthetization.

TECHNIQUE. MATERIALS

6424. A SIMPLE APPARATUS FOR THE PRODUCTION OF VERY SMALL HOLES IN THIN FILMS. E.Lorenz.

Z. InstrumKde, Vol. 66, No. 1, 14-16 (Jan., 1958). In German.

The drill consists of a W needle rotated by an air jet. Holes of 0.03 to 0.003 mm diameter were bored in 0.1 mm thick Al and Pt foils, and of 0.002 mm diameter in 0.05 mm thick foils.

S.Weintraub

621.95

PHOTOGRAPHY

6425. f/2.9 STREAK CAMERA. F.L.Brauer and D.F.Hansen.

J. Opt. Soc. Amer., Vol. 49, No. 5, 421-4 (May, 1959).

A streak camera with time resolution approaching that of the fastest modern streak cameras but with a considerably improved f/number has been developed. Only a limited number of geometrical configurations are practical in a no-dead-time streak camera. The important geometric factors are 2:1 conjugates, cylindrical type film plane, optical axis inclined 15° to turbine mirror to offset film plane from camera lens, and optical axes of camera and camera lens coincident. This solution forces the entrance slit to be inclined by 28° 12' to the optical axis. The "bending" of the light bundle by this angle at the slit is accomplished by a section of a Fresnel field lens of very large aperture. Time resolution is about 10⁻⁸ sec with an image quality of 16-20 lines/mm.

771.3

77 : 535.214.4
INSTRUMENT FOR THERMAL PHOTOGRAPHY. See
Abstr. 5473

77 : 612.843.613
LIMINAL IMAGE SIZE FOR CONVENTIONAL FILM READERS.
See Abstr. 6416.

6426. GRAININESS AND ENTROPY. E.L.O'Neill.

J.Opt. Soc. Amer., Vol. 48, No. 12, 945-7 (Dec., 1958).

A simplified model of grain is presented. Using a black and white checker-board pattern of varying macroscopic transmission, the entropy, as defined in information theory, is computed and plotted as a function of transmission and density. The similarity between the entropy v. density curve and empirically determined graininess v. density curves suggest the possibility that the subjective term "graininess" represents the observer's description of the disorder of the granular sample.

771.531 : 530.162

6427. ON THE POINT AND LINE SPREAD FUNCTIONS OF PHOTOGRAPHIC IMAGES. R.C.Jones.

J. Opt. Soc. Amer., Vol. 48, No. 12, 934-7 (Dec., 1958).

The paper describes the three basic functions used to describe the image forming properties of photographic materials. The functions are the line spread function, the point spread function, and the transfer function (spatial frequency response). Only one of the three functions is independent, and therefore three pairs of conjugate relations exist among them. All six relations are given explicitly. The relations are exemplified by deriving the point and line spread functions of Super-XX, Kodachrome, and Microfile film from the trans-

771.531

6430. DETAIL RENDITION BY PHOTOGRAPHIC SYSTEMS AS A FUNCTION OF EXPOSURE TIME. R.N.Wolfe.

J. Opt. Soc. Amer., Vol. 49, No. 2, 172-5 (Feb., 1959).

Photographs were made using several photographic systems, all having entrance pupils of the same diameter. Each of five lenses, varying in focal length from 2½ to 33 in., was used with five different kinds of photographic film. The lenses were the best that could be obtained for the purpose of this experiment. The films varied from a fast aerial film to a fine-grain film designed for document reproduction, but all were developed to a gamma of approximately 1.5. The test object was a transparency of a farm scene. An enlarged positive transparency was made from each negative to such a scale that the image of the scene had the same size in each one. It was found that the films of moderate and high speed recorded practically the same amount of detail for a given exposure time but that the document-copying films recorded much less.

771.531

6431. RELATION BETWEEN THE STRUCTURE OF SILVER BROMIDE GRAINS AND THE SENSITIVITY OF PHOTOGRAPHIC EMULSIONS. W.Waidelich.

Z. angew. Phys., Vol. 10, No. 11, 525-31 (Nov., 1958). In German.

Measurement of the half-widths of Debye-Scherrer lines for

771.531 : 548.736.3

grains of photographic emulsions showed that the size of the coherent lattice regions diminishes with increasing sensitivity. As the sensitivity also depends on other effects, a smooth relationship is obtained for a series of similar emulsions. It is concluded that latent image formation occurs mainly at the boundaries of coherent lattice regions.
J. Franks

771.534 : 519.2

6432. AUTOCORRELATION AND GRANULARITY. III. SPATIAL FREQUENCY RESPONSE OF THE SCANNING SYSTEM AND GRANULARITY CORRELATION EFFECTS BEYOND THE APERTURE. H.J. Zweig.

J. Opt. Soc. Amer., Vol. 49, No. 3, 238-44 (March, 1959).

For Pt. II, see Abstr. 994 (1957). It is shown experimentally that, although the granularity correlogram of a uniformly exposed and developed black-and-white photographic emulsion ordinarily extends only over a correlation distance equal to the diameter of the scanning aperture, correlation is exhibited over significantly greater distances when clumping is produced, e.g., by exposing to X-rays or developing to a high density. The difference between the effects produced by large and small scanning apertures is discussed, and it is shown that the variance for one aperture size cannot always be predicted from the variance for another. The procedure for combining the correlogram of a negative as affected by the printing procedure with the correlogram of the positive stock to give the correlogram of the print is discussed with examples. In the appendix, it is shown that the ordinates of the correlogram of the negative, as transferred to the print, are proportional to the square of the gamma of the positive stock and to the density of the negative. The importance of knowing the behaviour of the microphotometer used to obtain the correlograms is demonstrated by a practical example.

771.534 : 535.434

6433. THE INFLUENCE OF SCATTERING WITHIN PHOTOGRAPHIC EMULSIONS ON RESOLVING POWER [WITH SPECIAL REFERENCE TO LOW-CONTRAST IMAGES]. R.G. Giovanelli. Optica Acta, Vol. 5, No. 1-2, 27-30 (March-June, 1958).

771.534.3 : 537.312.5

ENERGY TRANSFERS BETWEEN CRYSTALS AND ADSORBED DYES. EFFECT OF CONCENTRATION ON EFFICIENCY OF SENSITIZATION. See Abstr. 5719

778.34

6434. ON THE INFORMATION-DETECTING CAPACITY OF PHOTOGRAPHIC EMULSIONS.

H.J. Zweig, G.C. Higgins and D.L. MacAdam.

J. Opt. Soc. Amer., Vol. 48, No. 12, 926-33 (Dec., 1958).

The concepts of quantum efficiency and detecting capacity of photographic emulsions are discussed with reference to the granularity, spread function, and characteristic curve of the emulsion. A measure of informational sensitivity is introduced which depends on these quantities and provides an objective measure of performance of emulsions when they are compared at their optimum working scales. In terms of this measure, as well as from a direct visual appraisal of picture quality, it appears that two emulsions, such as Kodak Tri-X Film and Kodak Panatomic-X Film, can have widely different sensitometric speeds but quite similar informational sensitivities.

LIST OF JOURNALS

The following list supplements the List of Journals published with the Index to Volume 61 (1958). Reprints of the List of Journals can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s.0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Arch. Meteorol. Geophys.
Bioklimatol. A.

Archiv für Meteorologie, Geophysik und Bioklimatologie, Serie A
(Meteorologie und Geophysik).
Springer Verlag, Mülkerbastei 5, Vienna I.

Instrum. Engr

Instrument Engineer.
George Kent, Luton, Bedfordshire.

Planseeber. für Pulvermetall.

Planseeberichte für Pulvermetallurgie (incorporating: Powder Metallurgy Bulletin).
Postfach 74, Reutte/Tirol, Austria.

Sci. American

Scientific American.
415 Madison Avenue, New York 17, N.Y.

Soviet Astron. — AJ (New York)

Soviet Astronomy — *AJ*. (A translation of the "Astronomicheskii Zhurnal" of the Academy of Sciences of the USSR).
Published by the American Institute of Physics, with the co-operation of the American Astronomical Society. Subscription address: American Institute of Physics, 335 East 45th Street, New York 17, N.Y.

Soviet Physics — Crystallography
(New York)

Soviet Physics — Crystallography. (A translation of the journal "Kristallografiya" of the Academy of Sciences of the USSR).
Published by the American Institute of Physics, with the co-operation of the American Crystallographic Association. Subscription address: American Institute of Physics,
335 East 45th Street, New York 17, N.Y.

NEW JOURNAL

Fiz. tverdogo Tela

Fizika Tverdogo Tela. (Physics of the Solid State).
 Publisher: Academy of Sciences Press, Moscow and Leningrad.
 Vol. 1, No. 1 dated January, 1959.

NOTE

Powder Metall. Bull.

Powder Metallurgy Bulletin.
Incorporated in: Planseeberichte für Pulvermetallurgie, from the end of 1958.

ERRATA

Abstr. 4202 (1958) line 2 : for "1957" read "1958".
Abstr. 5985 (1958) line 3 : for "1957" read "1958".
Abstr. 7116 (1958) line 3 : for "1957" read "1958".
Abstr. 3506 (1959) line 1 : for "AT" read "DOWN TO".
 last line : insert " (at 0°K)" after "field".
Abstr. 4689 (1959) line 14 : insert "by" before "Ba".
Abstr. 5549 (1959) line 5 : for "verge" read "range".

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Electronic Planets	The Atoms Grouped According to the Number of Outer (Valence) Electrons																Planetary electrons in the completed shells									
↓	I II III IV V VI VII VIII																Total Atom No.	↓								
↓	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18																↓	↓								
1 0 n Neutron 1.0087																	2 = 2 End of the 1st Period	1								
2 He 4.003	1 × H 1.0080																10 = 2 + 8 End of the 2nd Period	2								
3 Ne 20.183	2 × Li 6.940	4 × Be 9.013	5 × B 10.82	6 × C 12.011	7 × N 14.008	8 × O 16.000	9 × F 19.00	10 × Ne 20.183	11 × Na 22.991	12 × Mg 24.32	13 × Al 26.98	14 × Si 28.09	15 × P 30.975	16 × S 32.066	17 × Cl 35.457	18 × Ar 39.944	18 = 2 + 8 + 8 End of the 3rd Period	3								
4 Ar 39.944	19 × K 39.100	20 × Ca 40.08	21 × Sc 44.96	22 × Ti 47.90	23 × V 50.95	24 × Cr 52.01	25 × Mn 54.94	26 × Fe 55.85	27 × Co 58.94	28 × Ni 58.71							36 = 2 + 8 + 18 + 8 End of the 4th Period	4								
5 Kr 83.80	29 × Cu 63.54	30 × Zn 65.38	31 × Ga 69.72	32 × Ge 72.60	33 × As 74.92	34 × Se 78.96	35 × Br 79.916	36 × Kr 83.80	37 × Rb 85.48	38 × Sr 87.63	39 × Y 88.91	40 × Zr 91.22	41 × Nb 92.91	42 × Mo 95.95	43 × Tc 99	44 × Ru 101.1	45 × Rh 102.91	46 × Pd 106.4	5							
6 Xe 131.30	47 × Ag 107.880	48 × Cd 112.41	49 × In 114.82	50 × Sn 118.70	51 × Sb 121.76	52 × Te 127.61	53 × I 126.91	54 × Xe 131.30	55 × Cs 132.91	56 × Ba 137.36	57 × La 138.92	58 × Ce 140.13	59 × Pr 140.91	60 × Nd 144.27	61 × Pm 147	62 × Sm 150.35	63 × Eu 152.0	64 × Gd 157.26	65 × Tb 158.93	66 × Dy 162.51	67 × Ho 164.94	68 × Er 167.27	69 × Tm 168.94	70 × Yb 173.04	71 × Lu 174.99	6
7 Rn 222	79 × Au 197.0	80 × Hg 200.61	81 × Tl 204.39	82 × Pb 207.21	83 × Bi 208.99	84 × Po 210	85 × At 210	86 × Rn 222	87 × Fr 223	88 × Ra 226	89 × Ac 227							86 = 2 + 8 + 18 + 32 + 18 + 8 End of the 6th Period	7							
6 Rare Earths Type 4f	58 × Ce 140.13	59 × Pr 140.91	60 × Nd 144.27	61 × Pm 147	62 × Sm 150.35	63 × Eu 152.0	64 × Gd 157.26	65 × Tb 158.93	66 × Dy 162.51	67 × Ho 164.94	68 × Er 167.27	69 × Tm 168.94	70 × Yb 173.04	71 × Lu 174.99						7						
7 Rare Earths Type 5f	90 × Th 232	91 × Pa 231	92 × U 238	93 × Np 237	94 × Pu 242	95 × Am 243	96 × Cm 247	97 × Bk 249	98 × Cf 251	99 × Es 254	100 × Fm 253	101 × Md 256	102 × No 254	103					7							

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